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Understanding the Experience of Women in Undergraduate Engineering Programs at Public Universities

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Understanding the Experience of Women in Undergraduate Engineering Programs at Public Universities

The rate of degree attainment of women in the field of engineering has remained stagnant with 18.4% of all undergraduate engineering degrees awarded to women [1]. Even with consistent, targeted efforts in the last ten years, the number of women receiving engineering degrees has decreased slightly. While the rate of completion is well examined, the underlying factors, which help to explain why, have not been fully explored. To understand how women experience undergraduate engineering, three distinct stages in the educational journey will be examined: in the second year gatekeeper courses, during a senior/ upper division year near the end of a program in engineering, and after a degree has been obtained. These three phases of education examined in a qualitative fashion with a critical lens allow a truer understanding of the experience of women in undergraduate engineering programs.

Statement of the Problem

The "pipeline" into and through the field of engineering has been described as "leaky". The pipeline analogy has served to explain the lack of entrance and retention of engineers, in particular women engineering students. While many studies have been done to look quantitatively at indicators of persistence, there has been little done past the initial results. Lichtenstein, McCormick, Sheppard, and Puma [2] found students who work while in an undergraduate program, score lower on a calculus class, or have a lower quantitative score on the SAT are less likely to finish a degree in engineering. This finding is consistent with the literature that examines persistence as well as entrance into engineering. However, when examining SAT scores, Wang, Eccles, and Kenny [3] followed students transitioning from high school to college and found those students with a high verbal and high quantitative score on the SAT were less likely to enter the field.

This problem is compounded when examining women within the field. The number of women entering undergraduate engineering programs is low and declining from its height of 20% in 1994; attainment was still around 19% [4, p.7, and 1, p. 12]. According to the National Center for Educational Statistics (NCES) only 4.5% of undergraduate degree are given in engineering [5]. When this 4.5% is decomposed by gender, only 18.4% of undergraduate degrees were granted to women in 2011. That is to say, 0.8% of all degrees granted in four year universities are earned by women in the field of engineering. This rate has been continually declining over the last five years. A strong push by multiple agencies to expand participation by women and underrepresented minority students has fallen short. Existing literature points to a chilly environment for learning [6], lack of alignment of future life goals, and demands of the field [7], and unreasonable grading and academic demands [8].

Purpose of the Study

Looking at the leaky pipe has not made significant progress towards understanding all the dimensions of the problem. Women are not and have not entered or persisted in engineering. There is not one single factor that can be pointed to in order to explain why women are not receiving undergraduate engineering degrees. Previous explanations offered by the field have focused on student characteristics or looked at a single dimension. The interaction of curriculum, the field, subjective grading scales, unrealistic demands, and declining self-efficacy cannot be

separated from each other. A more complete picture needs to be formulated. The purpose of this study is to understand the social, structural and curricular constraints on the field of engineering and how they shape the experience of women during their undergraduate degree. To understand the experience of women in undergraduate programs, a qualitative methodology must be employed. In addition, a critical lens with the intention of social justice and contextual understanding must be used to more fully understand the unique characteristics of undergraduate engineering programs in public universities.

Significance of the Study

When the data about engineering degrees granted is disaggregated by gender and ethnicity, the picture is much bleaker. This fact is a mismatch to high school achievement data. According to Hill, Corbett, and St. Rose, girls out achieve boys in high school in both science and mathematics. Females earn an average grade 0.2 points higher than males on a four point scale and earn an average of 0.5 more credits in math and science [9, p. 5]. The new SAT re-alignment seems to have widened the overall gap in performance for males and females; however, women who consider Science Technology Engineering and Math (STEM) careers outperform males [10]. While these facts should give women a competitive advantage and encourage enrollment in college engineering programs, the rate of freshmen enrollment is only 18% [10, p. 7]. In other words, 82% of engineering undergraduate degrees are earned by male students.

When the rate of completion is examined by university type, the results show a different picture. Of the universities that granted the most degrees to women, by percentage, only three are public, land grant universities. These universities are University of Tennessee at Chattanooga, which granted 42% of its degrees to women, Tennessee State University, with 32% of the degree awarded to women, and University of Puerto Rico Mayaguez, where 31% of the graduates in engineering were women. The highest rate of women graduates at a state, land grant university in California was 15%. This is in direct contrast to the greatest rate of women degrees for any university; a small private college granted 35% of its engineering degrees to women. There were only two California private universities in the top 20 and no public universities [1, p. 15].

Most work done in regards to retention has been done from a strictly quantitative approach. In fact, many of the studies are limited in their definitions so they only begin measuring retention after completion of pre-requisite classes or foundational level classes, after the students are officially admitted to an engineering program, and/ or at the beginning of the junior year. Some of these studies show that the retention rate of students is equivalent to the rate of other majors, but do not indicate the low level of entrance. Others argue the rate is steady overall, but very few evaluate the study in terms of gender or ethnicity. This is due, in part, to the inability to get a sample sub-set large enough to consider. Moreover, little attention has been paid to the distinction between public and private universities and the rate at which they graduate women engineers. Regardless of the reason, a comprehensive study into the sociological, cultural and psychological reasons for the lack of persistence has not been completed. The field has been left with an incomplete scope that has yet to provide understanding of the underlying issues or the culture of engineering programs.

Once the experience of women in undergraduate engineering programs is more understood, universities and the field can make steps to alleviate the discrepancy in attainment rates between men and women and broaden participation. The use of a critical lens and qualitative

methodology will allow for a basis of understanding from which leaders in the field can examine their own practice, and authentic, deep, meaningful discussion can follow.

Research Questions

The experience of women in undergraduate engineering programs has not been examined through a critical and qualitative lens; nor has the question of university type played a role in the research. The hope is that understanding how women experience undergraduate engineering programs at public state universities, the broadest impact on participation can be made. The goal of this project is to look at various stages of a woman's educational journey in engineering to examine the following:

1. How do women experience undergraduate engineering programs at public universities?
2. What role does classroom discourse play in shaping women's experience in "gatekeeper" courses?

Three distinct phases of a woman's journey were examined. First, a sample of women who have already completed an undergraduate engineering degree from a public university was studied. Secondly, women in their upper division year of their undergraduate degree program were asked to reflect on their experiences over their undergraduate career. Both of these groups of women were asked questions from the same interview protocol. Finally, classes were observed and discourse was analyzed in gatekeeper courses to understand the interaction of women and their professors as well as women with their peers, both male and female. The lens of Feminist Post Structuralism and of Sense-Making allowed the critical analysis to shine a light on the underlying cultural, structural, and social characteristics women confront in undergraduate engineering programs at public universities.

Review of the Literature

The Public University

The CSU system is comprised of 23 regional campuses throughout California, 16 of which have at least one ABET accredited undergraduate engineering program [11]. For the freshmen entering the CSU system, the degree completion rate is under 60% even when the window is expanded to ten years. Those students who entered the system in 2005 have a four year graduation rate of 16.1%; and 40.1% cumulative rate of five year graduation. In 2006 the degree attainment rate took a dip as did the two year retention rate. The entering freshmen in 2011 have a 74.9% two year retention rate and a four year graduation rate of 19.1%. Less than one-fifth of the students system-wide are graduating in four years [11]. The rate of enrollment by women in STEM is forty percent the rate of their male counterparts. To compound the issue, the retention rate of women in STEM is consistently lower than their male counterparts (55.4% for women and 63.1% for men). In total the CSU system granted 5,707 undergraduate engineering degrees in 2016- 960 of these degrees were obtained by women and 4,947 were granted to men.

Engineering Degree Production

"In 2013, California represented about twelve percent of the US population and the public systems in California provided an education to approximately ten percent of engineering BS degree recipients for that year" [12 p.2]. There are 73 ABET accredited degree programs at the

23 CSU campuses. Although the CSU system has 73 accredited engineering programs in comparison to the UC's 54 accredited degrees, the system awards approximately 40% of the degree that the UC system awards [12].

Even though men qualify for college at a rate of 70% compared to their female counterparts across all ethnic breakdowns [11, p. 2], there is still a pronounced gap in the rate of degree attainment by women in engineering. This can be systematically due to selection of the major in part; however, the attainment rate of degree by women in California trails the national average. In 2013, the rate of degree awarded to women in engineering was 19.1%, in California it was 17.5% [11, p. 7]. This mismatch of readiness and attainment by gender in California is even more pronounced at the CSU campus and over the last ten years. Initially between 2005 and 2009, the CSU system experienced a ten percent decline in women engineering.

Self-Efficacy

Perceived self-efficacy is a judgment about personal capabilities that is influenced by and, in turn, influences performance, but is not reducible to objective skills. Rather, self-efficacy determines what we do with the skills we have [13], in particular for engineering students, Lent's measurements were based on a scale of no confidence at all to complete confidence in the ability that students had to handle issues that arose in their studies. These issues included dealing with lack of advising; ability to finish science requirements for the major; and ability to finish math requirements for the major [14]. For students that had a higher level of science and math self-efficacy there was a greater chance of persistence. In addition, Lent found that coping self-efficacy immerged as a factor that influenced persistence [13]. More often than not, if a student was earning a good grade in math and science, his or her self-efficacy in these areas was high [15]. However, the grades do not tell the story for women in engineering programs. Many of those who had the highest grades had the lowest self- concept of their skill [16][10].

Social, Structural and Cultural Issues

The field of engineering--in fact most STEM fields--struggles to attract and retain women. The pervasive reasoning is a cool environment or lack of role models in the field. Cech [17] found that as students progress through their undergraduates and graduate programs the socialization of the discipline led to a sense of disengagement to social responsibilities for the field. "[P]ublic welfare concerns [are seen] as tangential to what it means to practice engineering. This culture has three ideological pillars: the ideology of depoliticization, which frames any 'non-technical' concerns, such as public welfare as irrelevant to 'real' engineering work; the technical/ social dualism, which devalues 'social' competencies such as those related to public welfare; and the meritocratic ideology, which frames existing social structures as fair and just" [17, p. 45].

This dichotomy of relevant versus irrelevant, or fair versus unfair, frames the feelings of many engineers when it comes to their treatment of ethics. Unlike many aspects of engineering ethics looks mostly in hindsight, not at all with innovation. It is usually seen as a reaction to a crisis. This hindsight is framed by topics that were seen as unimportant, the first pillar of Cech's theory of disengagement [17]. The final pillar is prevalent in many undergraduate and graduate engineering departments to an extreme measure. Numerous studies have pointed to the need to weed out the weak students from undergraduate programs. This builds on the very foundations of engineering education as a vocational degree for the brightest students. This overarching concern with technical knowledge and merit based scholarship sets the ground work for a disengagement

of students and pushes out those with a wider world view. The study that Cech [17] conducted showed that students in universities actually decrease in their feelings of social engagement and responsibilities as they progress through their education. While the changes are small, they are significant and point to a larger problem with undergraduate education and the socialization of engineers.

Engineering Identity

The development of an identity as an engineer has begun to be considered a factor in the formation of a professional engineer. Capobianco, French and Diefes-Dux [18] looked at the connection of a student's ability to identity as an engineer and their persistence in an undergraduate degree and in the field. Various models had been used to approach the notion of identity--the stage theory; university affiliation; Gee's identity formation and a self-concept realization model. Much of this work was done longitudinally across an undergraduate's career as a student and has found that identity as an engineer is lowest as a freshman.

Gee's four-dimensional examination of identity formation focuses on: nature identity; institutional identity; discourse identity; and affinity identity [18 p. 700]. This frame is persistent in much of the current research on identity. Capobianco et al. found that women who had a strong institutional identity and affinity were more likely to persist in the field and see themselves as engineers [18, p. 111]. These women also had a strong academic affinity that seemed to "surpass their gendered identity" [18, p. 112]. It is interesting to note that all of the women within the study identified engineering as problem-solving orientated and some saw the field as a career to "fall back on" or a "means to an end" [18, p. 112]. While a utilitarian perspective on engineering is taken by the women, very few see that as the formation of an identity.

The issues that impact the formation of an identity as an engineer are more pronounced for women and underrepresented minority (URM) students in these areas. These groups report to have a higher affinity in some of the areas that are negative indicators for identity formation and therefore persistence. "Among college experiences, three experiences are significantly related to change in engineering identity. Students with greater concern for a career where they can work for social change, students who receive more mentoring and support from faculty, and students who experience more negative cross-racial interactions also indicate developing a stronger sense of engineering identity" [19, p. 22]. The notion that a stronger identity as an engineer is formed if a woman is singled out in class or clubs repeatedly seems counterintuitive. However the study points to the fact that as a woman or URM students are singled out the uniqueness of their identity is reaffirmed, among those students who persisted. The formation of an undergraduate's identity as an engineer is multifaceted and the interaction of gender, race, and socioeconomic status conflates the problem.

Conceptual Framework

Ontological and Epistemological assumptions

A critical frame was chosen because of the ontological and epistemological assumptions of the researcher. The critical lens informs the nature of reality [20]. The research is grounded in the assumption that reality is in the participants and that a dichotomy of us versus them is established. To truly know the social structure and the implications of this structure, the

participants' voices must be maintained and analyzed through a critical transformative lens. The fact that the participants are women who entered into a traditionally male field and have experienced or are experiencing their undergraduate degree sets the stage for a power differential as well as othering source.

Feminism Poststructuralism

Both the analysis of the literature and the data will be through the lens of Feminist Poststructuralism. This frame allows for a fluid interpretation of the data and preserves the voices of the participants and validates their lived experiences. It also shines light on the pre-existing structure that women negotiate and exist in during their undergraduate program. The underpinnings of Feminist Poststructuralism ensure a fundamental assumption that knowledge or understanding is formed socially by language, meaning, and subjectivity [21 p. 20].

Feminist Post-Structuralism. A critical frame that helps "address the questions of how social power is exercised and how social relations of gender, class and race might be transformed." [21, p. 20].

The Constructs of Feminist Post-Structuralism

Language and discourse. Language can be seen as the way in which we interpret our lives and navigate through society and make meaning [21, p. 85]. The plural nature of language makes it almost impossible to fix meaning of language. The discourse is the set of competing values that give meaning to the world, social organizations or processes [21, p. 35]. Language and discourse maintain the status quo and define power relationships through commonly shared values. The controlling aspects of discourse create a ranked duality of beliefs that value one over the other and silence those without authority. In poststructuralist theory, "Language is the place where actual and possible forms of social organization and their likely social and political consequences are defined and contested. Yet it is also the place where our sense of ourselves, our subjectivity, is constructed" [21 p. 21]. Language develops the social reality that we live within.

Subjectivity. "The conscious and unconscious thought and emotions of the individual, her sense of herself and her ways of understanding her relation to the world" [21,p.32]. Weedon goes further to explain that subjectivity is a person's position within the discourse [21, p. 34]. This positionality assumes a dichotomy between marginalized and non-marginalized groups and establishes a power differential. Subjectivity results in a fluid sense of self and makes it harder to define an identity. When a woman in the field constantly references her knowledge or achievement based on a nebulous expectation or the performance of other classmates, there is not a defined sense of self-- just a comparative norming. This leads to an ever-changing baseline and does not allow for a firm footing to be established and built upon. It also does not allow for formation of an independent identity.

Common Sense. "A number of social meanings and the particular ways of understanding the world which guarantees them" [21, p. 77]. Common sense are those facts the society takes for granted- like all students in advanced math classes know their multiplication tables. The facts we assume as commonplace knowledge and accept without checking are common sense notions. In education, this could also include background knowledge gained in high school or in previous

years of formal education, or even in the home. By looking at those assumptions, we can begin to understand what a society values.

Power. A relation that assumes a difference and creates a dynamic of control and lack of control [21 p. 113]. Power is institutionalized by an agent that seeks to assert dominance over another. Anytime people are not on equal footing, there is a power struggle. Some examples include- teacher/ student, parent/ child, priest/ parishioner, and holder of knowledge/ seeker of knowledge. This differential can be exploited to gain control over the less powerful of the two parties. The examination of power as a tenet of the frame, creates a dichotomy that is in line with the structure implied in the field. There is definitely a differential of power establishes and reinforced by the direction of knowledge flow.

Methodology

Design

The project was designed in a three-stage method. Each of these stages worked together to validate each other as well as create a longitudinal picture of a woman's experience in undergraduate engineering programs. The largest group of data was gathered from interviews with women who were completing or had completed their undergraduate engineering degree. These women self-identified for the project after solicitation by the researcher. The interviews for both groups of participants consisted of interview questions. The interview protocol was designed to further probe major themes in the literature especially those that have emerged from the work of Hewitt and Seymour[22],Cech et al.[7] an [17], Pauley et al.[23], Slaton and Riley [24] and to shed understanding on those findings from quantitative work done by Lichtenstein et al. [2], French et al. [25], Hill et al. [9], Craincross [26] and Wang et al. [3] to mention a few. The questions were intended to address how the women dealt with typical barriers as they encountered them, self-efficacy, early introduction to the field, interaction of home, work and school factors, seeking out of role models, the role of professional clubs and organizations as well as the notion of persistence when confronted with curricular, cultural, or societal struggles.

The discourse analysis served two purposes for the project. The first was to extend the picture of the experience to an earlier stage and develop a notion of identity formation in the beginning of the program. That is to say that discourse provided a baseline view of the culture the women interact with. The second function of the classroom discourse analysis was to validate the findings in the interviews. This then provided a way to triangulate the data since both the interviews and classroom observation occurred at the same universities.

The use of critical lenses allowed for analysis of the literature and data in a way that made meaning of the interview data as well as the discourse analysis. As discussed in previous chapters, multiple lenses informed the analysis of the data. These lenses include Feminist Poststructuralism, Resilience, and Sense-Making. Feminist Poststructuralism highlights four aspects of poststructuralism theory as previously defined by Foucault.

> The least that a feminist poststructuralism can do is explain the assumptions underlying the questions asked and answered … making their political [and social] assumptions explicit. Poststructuralism can also indicate the types of discourse from which particular feminist questions come, and locate them both socially and institutionally [21, p. 20].

By focusing on the four tenets of the frame focused understanding and meaning was able to be developed. These areas include: Language and Discourse, of particular importance during the

classroom observations, Power, Subjectivity, a major focus of the analysis, and Common Sense. These four aspects worked together to inform a more rich analysis of the issues and experience of the women in the study. Much of the data analysis and follow up interview questions were informed by the frame of sense-making. This frame provides a way to understand how the women in the study define their position in the discipline and how they interact with and develop meaning from the discipline. Ultimately these two frames led to an understanding of the development of a situated identity within the field.

The design of the study was by no means an exhaustive study of the experience of women in undergraduate engineering programs. The study was cross sectional in its intent; however, it did not follow the same cohort of participants along the completion of a degree. The three data points represented in the study were intended to give a broader snapshot of the experience. All the women were self-selected participants and those who were current students were largely involved in at least one professional club within the department of engineering at their schools. That is to say that the students who are not involved in clubs, but are enrolled in engineering programs were not, or may not have been captured in the data. This means that students who work full time while attending school, attend night or nontraditional course offerings, or were unaware of the existence of the professional clubs were not part of the sample. This could include numerous first generation students, those from a lower socio-economic background, or those who are non-traditional students to name a few. In addition, the course selection for the observations implied a completion of calculus and physics. This means that those students who were first entering the field were omitted from the analysis. Finally, while the women in phase two of the analysis all obtained their degrees for the same university system as the participants in phase one, they did not necessarily obtain their degree from the same university. Even though all the participants attended one of two universities, the faculty may have changed so the experiences of the women would not have matched exactly.

Participant Selection

The study was focused on understanding the experience of women in undergraduate engineering programs and how classroom discourse as well as lived experience influenced the completion of the course of study. To that extent each phase of the study had differing participation selection. The first portion of the interview was completed with women who had already obtained a degree in engineering. The second group of participants in the interview was women in their upper division portion of their undergraduate degree program. All of these women attended one of two universities in the study.

After Degree Completion (Professional) Interviews

Women who have already completed an undergraduate engineering degree from an ABET accredited program at a four-year public university were compiled in the study. These engineers identified as women during the completion of their undergraduate degree. The fact that the women were granted an undergraduate degree in engineering was the only requirement to be part of the study, some of the participants completed or enrolled in a master's level program; however, this was not a requirement for the study. Not all of the women pursued careers in engineering after degree completion and others did not remain in the field of engineering. Employment status was not a consideration when selecting participants for the study.

The women were solicited for participation through professional clubs, however, in this portion; the solicitation was through the professional society's web page or college alumni page. Many of the women were highlighted as notable female alumni from the engineering department. Other participants were referred to the project by word of mouth, either from male engineering colleagues or others familiar with the project.

Prior to Degree Completion (Student) Interviews

The women in this set of data have two criteria in common: they identify as women and have completed approximately two thirds of their discipline specific engineering classes including laboratory classes. This level of completion assumed that the participants had also completed their calculus and physics requirements as well as foundational engineering courses appropriate to their discipline. Much like the graduates, these participants were solicited in a variety of manners including presentations at club meetings on campus, through the department website and professional workshop registries. Like the participants in the professional group, the student participants were completing an undergraduate engineering degree from a public university within the same system. All of the women who participated in the study attended the same two universities.

Table 1. Participants in Interviews

Identifier	Phase	University	Discipline	Ethnicity
RU	Professional	1	CE- Transportation	Hispanic
TC	Professional	2	Electrical	Asian/ Pacific Islander
JT	Professional	2	CE- Construction	Hispanic
KS	Professional	2	CE- Construction	White
AB	Professional	1	Civil (CE)	Hispanic
MB	Professional	1	Civil	Hispanic
JA	Professional	1	CE Transportation	Hispanic
SM	Professional	1	Chemical Eng.	White
RC	Professional	2	Mechanical	Hispanic
NS	Professional	2	Electrical	Persian
VG	Professional	1	CE	White
EC	Student	2	CE- Structures	Asian/ Pacific Islander
AE	Student	1	Industrial Eng.	African American
RY	Student	1	Mechanical	White
PM	Student	2	CE- Environmental	Hispanic
KC	Student	1	Civil	White
PH	Student	2	Mechanical	White
JB	Student	2	CE- Environmental	Indian
SR	Student	2	CE- transportation	Hispanic
JG	Student	2	Civil	Hispanic
RA	Student	1	Civil	Pacific Islander
ER	Student	1	Mechanical	Hispanic

Classroom Discourse Analysis

Each of the courses observed for discourse analysis are considered foundational to the field of study in engineering. There are a variety of gate keeper courses in the field including but not limited to: the calculus series, physics series of courses, and chemistry series. These course sequences are defined by criteria area five curriculum ABET accreditation guidelines for

engineering program accreditation. The criterion requires that (a) "one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline. Basic sciences are defined as biological, chemical, and physical sciences" [27]. These course are required for all engineering majors and as indicated in the literature, are a large reason that students leave the field of engineering. However, to ensure that only engineering students are observed, criteria 5b of the ABET accreditation guidelines were considered. This guideline requires

> (b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs. [27]

These courses were specific to engineering students and required a synthesis of information previously learned in other departments. The foundation level courses in this series were those that were used in the analysis.

The course level and type were the criteria for selection for discourse analysis. The status of the instructor, department, time of day, repeat status of the students enrolled or those enrolled in the laboratory components were not considered when selecting the section of lecture however, status of the instructor and time of day were noted in the analysis.

Procedures

Interview: Prior to degree completion (student) and After degree completion (professional)

The initial sample protocol was formulated based on primary analysis of the literature as well as the constructs of the theoretical framework. Many of the questions were aimed to get at the chilly environment Seymour and Hewitt [22] had pointed to in their seminal work on women in engineering. Those questions about how a woman felt as an engineer and how they saw themselves interacting with the discipline were left towards the middle portions of the protocol. Burtner (2005) examined the demands of balancing work during and undergraduate career and how those non-cognitive factors influenced persistence in engineering students. Lent et al. [14] looked at the outcome expectancy in choice and persistence of the field of engineering. Finally, Marra et al. [10] looked at the change in self-efficacy of women in at the end of their second-year of engineering.

The protocol allowed the researcher to probe these themes as well as a general sense of self efficacy and identity as an engineer in the initial protocol. As the interviews progressed, the protocol evolved to address the incongruity between life goals and gendered roles within the classroom that the women were experiencing. This is founded in the work by Cech et al. [7] and [17]. The interviews began to probe further the notions that the women were expressing of their disengagement from the field.

Classroom Discourse Analysis

There was a variety of data collection methods employed using Gee's discourse analysis [28] during the observation of foundational courses. A complete course of Statics was observed and interactions were noted. To validate these findings, two additional sections of statics with a different professor were observed for one week. In addition, observations were conducted for one week in two sections of Dynamics and two sections of Strength of Materials. Diagrams of the course of the conversation were used to track the interactions of the class at large. Special attention was given to the amount of time each member of the class spoke. Professor to student interaction was tracked as well as student to student interaction. While these interactions were being observed, the researcher noted for body posture, use of language and academic terms, as well as intonation of voice. Critical discourse analysis allowed the researcher to code for both order of the discourse and the interaction of participants.

Gee defined six building tasks of language that inform a situated identity- semiotic building, world building, activity building, sociocultural identity and relationship building, political building, and connection building [28, p. 8]. Of these six building tasks, the discourse analysis focused on five of the six tasks, leaving activity building less of a focus of the analysis. This decision was informed by the context of the study- classroom observations in a lecture undergraduate class were not anticipated to be referencing activity. The five identified building tasks informed the subjectivity and language and discourse of the Feminist Poststructural frame, while the sociocultural also informed the power dichotomy present; world building and connection building inform the understanding of common sense.

Table 2 Classroom Observations

Course	Length of observation	# of men in the section	# of women in the section
Statics**	One full term	32	4
Statics	One week	29	6
Statics	One week	27	6
Dynamics	One week	22	8
Dynamics	One week	30	6
Strength of materials	One week	39	10
Strength of materials	One week	33	15

Note: ** These sections were observed as a video feed from the university.

Instruments

A majority of the project focused on the interview data and voices of the women in the study. These data were gathered using the previously described interview protocol. During the classroom observation and discourse analysis a variety of tools were used. In order to look for elements of the curriculum and instruction that shaped the understanding of the women, the Reformed Teaching Observation Protocol (RTOP) was used. This tool was developed by the NSF and Arizona State University to specifically observe science courses. For the purpose of the study, section V Classroom Culture was considered the most heavily, however other sections were used. The classroom culture of the protocol is divided into two main focus areas: Communicative Interactions and Student Teacher Relationships.

The indication statements for Communicative Interactions are as follows: (RTOP, 2000, p. 41-46)

a. Students were involved in the communication of their ideas to others using a variety of means and media.
b. The teacher's questions triggered divergent modes of thinking.
c. There was a high proportion of student talk and a significant amount of it occurred between and among students.
d. Student questions and comments often determined the focus and direction of classroom discourse.
e. There was a climate of respect for what others had to say.

The indication statements for Student Teacher Relationship are as follows:

a. Active participation of students was encouraged and valued.
b. Students were encouraged to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence.
c. In general the teacher was patient with students.
d. The teacher acted as a resource person, working to support and enhance student investigations.
e. The metaphor "teacher as listener" was very characteristic of this classroom.

Data Analysis Methods

The interview data was coded in various rounds as prescribed by Saldana [29] and Bazeley [30]. The first round of codes was open coded and started after the first two interviews were completed and transcribed. As the interviews progressed, the codes developed in the open coding were compared to those in the pilot study as well as refined in later interview transcripts. Data was coded in at least three formal rounds of coding to ensure that all aspects of the study were reached and there was not overgeneralization. After a list of codes was developed, the interviews were all recoded according to the protocol codes.

In order to assess pedagogical practices in the classroom, various statics and sophomore level engineering courses were observed. This allowed a variety of course sessions to be observed and a more complete picture of the class to be formed. The courses were observed for pedagogical practice with the Reformed Teaching Observation Protocol (RTOP), developed in 2010 by Arizona State University and the National Science Foundation. The discourse was analyzed according to Gee's discourse analysis protocol [28].

Trustworthiness

To maintain trustworthiness of the process, inter-coder reliability was measured and the preliminary codes were vetted by one participant. The recorded interviews were transcribed and kept in a secure location. A set of codes was established from in vivo themes in the data. The analysis of these transcripts was checked against the literature, as well as an additional coder. During the process of the analysis, a reflective journal and analytic memos were kept to record, rationality, assumptions, and conclusions made during the data analysis process. After the findings are finalized, the report was available to each of the participants to ensure validity of the findings.

During the classroom observations and discourse analysis, the process of ensuring trustworthiness looked towards Gee's measures of validity [28p. 95]. The linguistic details of the classroom interaction were noted and maintained. This preserved the voices of the participants and their interactions with professors and peers. The discourse analysis worked towards

convergence of the data by focusing on the building tasks of language that informed the study and answered as many of the guiding questions proposed. These included [28, p. 93-94]:

- "What systems of knowledge and ways of knowing are relevant to the situation? How are they made relevant?
- What social languages are important and how is that value conveyed?
- What relationships, values and identities are deemed relevant to the field?
- How do the relationships and identities transform or stabilize the situation?
- What Discourses are relevant with regard to the relationships and identities? How is that conveyed?
- What social goods and networks are valued?
- How do these values operate in the Discourse?
- What connections are part of the interaction?
- What connections to future interactions are made?
- How do these connections build coherence?"

Findings

Theme 1: The Journey of a Cultural Migrant

Because you have to have a lot of voice. You have to be stronger. You have to be more confident- because you're a girl and its male dominated. So I think that it was actually helpful [to be judged earlier].You are not going anywhere if you are quiet or the little girl in the corner, you have to hang with the boys… (KS, professional)

UNESCO defines a migrant as "any person who lives temporarily or permanently in a country where he or she was not born, and has acquired some significant social ties to this country" (UNESCO, 2017). The commission on human rights goes further and defined a migrant as, "Persons who do not enjoy the general legal recognition of rights, which is inherent in the granting by the host State of the status of refugee, naturalized person or of similar status; those who are outside the territory or State to which they are nationals or citizens…" The concept of migration then implies the "there is a change in ties of social means" and that the migrants are "active agents in the movement" (UNESCO, 2017). If these definitions are applied instead to a cultural or educational migrant, the journey of women in undergraduate engineering programs becomes clearer. As the definition implies, the women experience a change from the culture that they are born into in order to enter an undergraduate engineering program. The women have also expressed a departure from their previous life, friends and family, and embarking on a journey that very few understand.

Early entrance into the field

The women in the study largely fall into two categories: those who have parents with a STEM degree or those who have experienced success in a STEM class or activity before entering college. The women with parents in the field felt like they were raised in the field so that even if engineering might not have been their first thought, the seed was planted early.

> I have two brothers and my dad are engineers, my grandpa was an engineer so it was like a family tradition. So when I was in college I didn't know what I wanted to do so my dad suggested engineering. He said that I think you'll be really good at this... I think that was definitely my initial push but as I learned more about it, it wasn't just that. (RC, professional)

Most of these women, with the exception of NS, had male role models for their entrance into the field. “My dad’s in power… [My mom is] an engineer too. She practiced engineering and then she stopped when I was born” (NS, professional). Even though NS’s mother had a degree in engineering, she left the field to raise children and had not returned to the field. She cited her father as her role model to enter the field. That is to say that even though they have a parent that had a degree in engineering, the key parent is the father. JB called special attention to the fact that she was breaking down cultural barriers in her family by being a woman with an engineering degree. “All the men in my family are engineers. There’s no female engineers except for me and I like to be the first” (JB, student).

In contrast, the second group of women, those with an early STEM experience, identified a particular class or teacher that exposed them to the field of engineering. Some of the women identified an after school or summer enrichment programs as the first success in STEM. … I do remember where I started with engineering. When I was in sixth grade, I took a science class after school program. It was NASA engineers who would come out and there was a lot of people in the class. I was the only girl. And they would have meet once a week… Things were so simple and it was all physics. They talked about friction in little cars and I remember one of them was so easy for me but it was so fun. It was the funnest thing in the world. (RU, professional)

Some of the women with an elementary school exposure did not even remember the experience until much later in the interview. Often times, the women pointed to another factor as connecting them to the field or credited their personal prowess for entrance into the field.

A portion of the women identified a high school class as their exposure to the field. These courses include drafting, robotics and other technical electives. A few of the women cited a physics or chemistry class as their exposure to the field, but these courses were never a standalone factor like the technical elective.

> Originally [I] wanted to be high school math teacher but my mom encouraged me to take a drafting class. So after that drafting class, I went to robotics and robotics design. Often during those classes we had engineers come and talk to us and really had a kind of mentor for us. I didn’t really know what engineering was. I don’t even think of it as an option I didn’t really even know it existed. (KC, student)

The women were invited into the field of engineering by early exposure to the field either through parents that had a STEM degree or an early exposure to the field. PM was the latest in the group to have the exposure to the field, however early courses in her collegiate career and a caring professor mentor who encouraged her into the field and continued to support her in the process gave her entrance.

> I know that I needed to choose something to transfer. Everyone in my calculus classes, I noticed, were going to engineering so I thought that’s what I would take it too… I took a surveying class at the junior college. It seemed really fun and interesting. My professor was really interested in me and pushed me... I had a good experience working in his class. [It was] my last year the in the junior college. Before that I was floating around. (PM, student)

For these women, there was a class either in the high school or community college in which she experienced success. This exposure to the field made the women confident active participants in the choice of engineering and allowed them admittance into an educational culture that they may

have not previously identified as their own. The women entered the field with the assumption that it was a culture they were acceptable to enter.

The early exposure to the field was in conjunction with strong analytic skills. All of the women identified that they are "good problem solvers" and see engineering as a puzzle to solve. Often, the women saw the foundation of their skills as engineers as being proficient at mathematics. "I was really good at math and… I only knew I could be a math teacher or mathematician in school" (JA, professional).

> I was always really good at math and I wanted to apply it somehow, but I didn't want to be teacher. Because I just (pause) I don't have the patience to teach someone that skill (pause). So I thought engineering was a great way to go because it's all math. (KS, professional)

A strong mathematical inclination is combined with an ease of science for some of the women.

> In high school I really liked my chemistry teacher and I just found a passion for chemistry. And I really liked math so (pause) I was wondering what to do with my life. So I combine those two- chemical engineering. (SM, professional)

By and large, the women saw their mathematical skills as a necessity to make them successful in the field. Many of them women saw their skills in addition to a lack of success in English Language Arts as a perfect fit for the field. The exception to this is PH who found engineering as a mixture of analytic skills and artistic ability.

> For the longest time the only thing I thought [all] I could do was be a math teacher with math. I know that I could take being good at math and being artsy [and put] them together and that kind of [is how I got to] engineering. (PH, student)

Leaving one life for the other

I do miss family events and that is not my family. It was really hard. They've gotten better about it but I still get the… I miss a family function... My nephew was here every day during my spring break and had to come in every day for a project. So [because of] that I wasn't able to spend time with him. He's a baby I want to spend time with him. I just look at their snapchat I guess. (PM, student)

The notion that the women are migrants into the field of engineering calls special attention to the fact that the women change their ties of social means and therefore have had a change in their social relations that is very substantial. While most of the women did not physically leave their home environment; most of the women lived at home and commuted to campus or lived close enough to go home on weekends; but they report isolation between their school and family lives. The women told of leaving behind their friends and family and entering into a field that no one else understood. This fact led to a feeling of isolation, and having very few people to turn to for help. This sentiment was particularly true for first generation women, as will be discussed further below.

> They [my family and friends] knew it was tough. And they knew if I was ignoring them for an extended time it was because I was doing homework all the time… If I haven't seen my parents in a long time I know I need to hang out with them. I haven't seen one of my friends I had to hang out with them as well. (KS, professional)

The women also felt like they were leaving behind old expectations of being. The women discussed the change in the way they were viewed from the prior expectations. "It was a little

frustrating. I certainly felt that there was this reputation that I had to hold onto… The people know to be a straight A student but…" (MB, professional).

Not all the women found the journey to engineering isolating. One of the women, VG, saw the journey as an escape from an illness and unstable home life. She described school as her place of refuge, a place where she was in control of the outcome and something that she could throw herself into completely.

> As a woman [it] never occurred to me. I've always been different. And so I never (pause) The difficulty of being the girl in the room and all that other good stuff. That's never bothered me. But I had health issues and I was working and I was commuting and even though I had [my dad, I] really didn't have support at home. And the tremendous amount of pressure I put on myself to perform… I was really messed up because of a family stuff. Not because of the school stuff. (VG, professional)

Even school could be an isolating place for the women. The women had left their home life and previous friends for the demands of the undergraduate program; they were still separated from the rest of the college. The women reported that their experience was totally different from their friends that are in other majors. This sense of separation insulated the women from the rest of the university and the social scene. This means the women were unable to spend time going out with friends, dating, and making real connections across the university while in their undergraduate program.

> I think I am definitely having a different experience than my friends in other majors. I see my friends on social media and they are out and like partying and having a social life. I guess they just don't have the same load of classes like we do. We have more homework. I feel like they never have homework... I definitely feel like they have it easier and have a social life. They post stuff, they have more followers than I do. (JG, student)

The one women who reported having a strong connection to the university outside of the college of engineering was RA who worked as part of a work study program at the Asian Pacific Islander center. She reported that the Asian Pacific Islander center was where she felt the most home at the university. "I also work with Asian American Pacific Islander Center. I really feel like that gives me an opportunity to reach more people especially in the Pacific Islander community" (RA, student).

Understanding new cultural norms

They didn't really say anything except for just do it. It was a lot of crying a lot of late nights. A lot sitting in office hours and just living there but I did it. It's so frustrating. Looking back on it even more frustrating. (SM, professional)

When the women entered the established culture of engineering, they found themselves having to adjust to new ways for being. The masculine shop culture of engineering was pervasive in the departments according to the women. This echoes the chilly environment Seymour and Hewitt [22] have pointed to and was a shaping factor of the subjectivity that the framework of Feminist Poststructuralism defined. Like any immigrant, the women are on a journey to understand the behaviors that are expected and accepted in the field of engineering. This discourse illustrated that the primary asset valued by the field is intelligence. The women quickly adjusted to the sense that they must be intelligent and this was accomplished, in part, by hard work.

> I just didn't want to sound stupid in a sense. So I never wanted to ask them questions…. I just know I picked the tough degree and it was going to take time so I stuck with it but I needed to work too. (JT, professional)

The classroom discourse confirmed this value. "You should spend 6-10 hours, depends on your strength, on the homework set. It's a serious case because when you do that you will be all smart because you learned a lot" (Professor Statics). However, hard work and intelligence was not the only way that the women adhere to the norms.

> I don't ask questions in class… I think that most of the time… I don't know. I think that most people that don't ask questions in class. It's out of fear that you don't want to be judged by your peers or the professor that they are dumb and asking a dumb question that they should already know. I have seen professors give the look after a student asks a questions. They don't straight out say it but they make the "really?" face. (ER, student)

The use of tools and technology was an expectation that the women felt that they were assumed not to have. The women felt empowered by their knowledge of tools and the constant struggle they had to prove themselves proficient with tools.

> I really know how to weld so I went to the steel bridge team and asked if I could be a welder and [I thought] they would be happy [to have me] because I knew how to weld. They had people who didn't know how to weld welding. He gave me a job just polishing metal which was dumb because I can weld. I should be able to weld…It left me really angry so that I skipped a year on steel bridge because I was so sad about it. He treated me differently because he didn't think I could do something. (RA, student)

On occasion, the women's ability with tools and ways of being was called into question by their male peers. Some of the women noted times when the men in their department intervened and tried to assist the women with tools.

> One thing about guys is it is like sometimes the guys will try to help before you ask for it. A lot of the other girls have noticed it like we have to be okay with just doing our work and letting them do their work. I know what to do and [they] are trying to jump in. [I have to say] "I know it is a mallet and I know what to do" (EC, student).

Building a new social network

The women developed a variety of methods to cope with the new culture in which they found themselves. To ingrain themselves to their new surroundings, most of the women joined professional clubs. These clubs served a variety of purposes: to connect with other women, other students of the same ethnicity or the same major. This is a process that evolves as the students progress through their degree process. Those students who do join Society of Women Engineers (SWE) or ethnic professional clubs such as Society of Hispanic Professional Engineers (SHPE) or National Society of Black Engineers (NSBE) often join at the beginning of their college career. As the women enter their upper division and laboratory classes, they became more involved with their professional associations such as American Society of Civil Engineers (ASCE).

> Freshman year, I was immediately involved with the MEP program and SHPE program. Those are both minority support clubs. So that (pause) I think that (pause)I think that's where I initially flocked to was that support group; people that were (pause) similar to me. [They] came from similar backgrounds. It evolved over time. I got more involved in other clubs. [As I progressed], I got more involved in the department outside of the minority organizations. I started making friends at ASCE. (AB, professional)

All of the women who participated in the study were involved in a professional club at school except for one. SM claimed that she was only slightly affiliated with the professional club for her major, chemical engineering, but she never attended a meeting.

> I don't know (pause). I wanted to go to some of them. But with work it was inconvenient for me. It was (pause) a long way for just that. So I went to campus Monday Wednesday and Friday and a lot of things happen Tuesday Thursday so I just didn't attend many. (SM, professional)

The initial acceptance and benefits of the professional club definitely changed of their undergraduate career. KC explained the evolution of her connection to her professional club:

> I'm an officer in American Society of civil engineers so I feel little biased but I think that the activities in the civil engineering club are a little more directed towards me as opposed to being general. I attended some of the society of women engineers' events but mostly just events. (KC, student)

This sentiment was reflected across the data set. Most of the women spoke about the benefit of their professional society. The women found a connection to their profession, as well as mentorship within their department and development of leadership skills. If I wasn't part of my student groups my experience would not be a fulfilling as it is now.

> I can't imagine my college experience without them. I really never got to travel before [my clubs]. My parents never had the resources to travel and now I've been to Philadelphia and Seattle. (AE, student)

Not all the women felt embraced by the professional clubs on campus. The women reported some of the clubs as cliquish or unwelcoming. The feeling of isolation was mostly discussed by the women when discussing SWE. A number of the women found SWE to be largely populated with one major. RC (professional) noted that "it was as if there wasn't enough room at the table for everyone. Like if I was part of their club I was taking attention away from them." Isolation within professional clubs was discussed by many women.

> I felt like [academic support] program and MEP… I felt because I didn't speak Spanish and I wasn't Hispanic, I didn't fit in. And I finally felt and this is just ridiculous. It was supposed to be for enrichment so we should be enriching. I even worked for [the academic support] club for a year and I still felt like I was the odd one out. It was like I will try to engage in conversation but you want to talk to me like I was the outsider. (NS, student)

Outside of their professional clubs, the women also built a peer group. These groups were usually smaller groups that formed during a foundational course. The size of the group was typically around four but up to eight. The groups are all mixed in gender and ethnicity and the women are typically the only women in their peer group, or there is one other.

> You start to notice a pattern where everyone's in the same class. We all have the same math class. We started making new friends. That kind of becomes your support group you help each other out with projects and homework studying. That's what kind of held us together and pushed us forward from class to class. (JT, professional)

The peer groups were largely transactional and depended on the courses in which the women were enrolled. Some of the women struggled to make a peer group that was functional for more than one academic term at a time.

> I have a couple groups of friends. I have my peer group, my nerd herd. Then I have another group of engineers but it's kind of a mixture. [The second group is] probably my closest group because I went through school with them. But I didn't have the same classes with them. They were older year older. I hung out with them other than at school. (KS, professional)

Wearing the mask of an engineer

…you have to learn how to speak their language and convey the message is that you still want conveyed…(MB, professional)

The women learned to navigate the system of being in engineering. Many of the women still saw themselves as an outsider and met the expectations of engineering with a sense of defiance. This unwillingness to relent to all the expectations was a way of sense making as well as maintaining their own sense of identity. One way the women dealt with the sense of being an outsider is to make use of their "soft skills."

> I did really well in my technical communication class. It's not necessarily math class or anything like that we didn't do math but it was more about speech and communication skills. I was able to learn more about myself and really apply it to my speaking style. I was able to communicate really well. (RA, student)

These communication skills were the way the women validated themselves as an engineer. Their ability to communicate needs and allocate work validated their progress in the field.

> I delegated and we got the work done and when it was a presentation it was awesome. I feel like, because of my communication skills I did really well in delegating and holding everyone accountable to their part of the project. I feel like engineers are introverted and they lack, the ability to communicate… My communication skills and my ability to communicate with others about what the issues are or what the plan is have benefited me all along the way. (JA, professional)

However, the communication skills the women possessed pigeonholed them in the field. "Whenever there is a group project in class I am always in charge. Unless there is another girl in the group, which is rare. Then we take turns being in charge" (SR, student). This means not only being the leader of a group, but also doing tasks that are devoid of design.

> I am one of the data acquisition sub-team, which takes care of the other sub-team's calculations, we validate the calculations. We try to see that it is working how we want it to work. If not we use the data to give to next year's team. I like it ok; but going back to the male female ratio. It can be a little overwhelming since I am one of the two girls on the team. It can be really isolating. Very frustrating. (ER, student)

The sense of validation as an engineer through communication and management skills was a theme echoed throughout a variety of the interviews and reflects Cech et al.'s [7] work on gender roles in engineering.

Communication was not the only skill the women had noted they had developed over the course of their engineering degree. Many of the women discussed a bending to the demands of the field. Not only do they study all the time, they sacrificed their other courses to succeed in their engineering courses.

> I had good study habits… I studied a lot. I spent a lot of time on it. I feel like it did ok in dynamics and fluids because I spent so much time on them. My other classes suffered

> though. I didn't do well at all in my GE classes because I didn't have the time for them. (ER, student)

While the demands of an undergraduate engineering degree were enough to disengage many students, the women in the study all approached the field with an air of defiance.

> Obviously, when I failed that one class I was devastated...It was just an awful feeling... So it's just so interesting because (pause) When I failed it (pause) I remember it was my second year probably and I called my sister and she said, "Oh my goodness you should just switch majors don't even do it again." That never even crossed my mind. I'm not getting to the level of class to stop you from doing what I want to do. It was only one class. I'm not letting one class get me. There was no way. I'm in to pushing through. It was more of a challenge. I wasn't going to be beat. I wanted to finish. (AB, professional)

Theme 2: Negotiating Comparative Norming

Comparative norming is the defining of one's performance or worth in reference to another classmate, expectation or nebulous desire. This fluid sense of identity and knowledge led the women to struggle for footing and made it nearly impossible for the women to have a defined place in the field. This norming drew on the notion of subjectivity and the multiple layers of power differentials and marginalizing characteristics that women negotiated during their undergraduate studies.

Formation of a situated identity

In their undergraduate programs, the women struggled to find footing and a way to measure their progress. Much of the measurement the women did in comparison with their peers. This could be something as being above the curve in a class, studying harder than their peers, or being treated differently than their peers by colleagues and professors alike. The women were always seen as women first and then as engineers even if they were being successful in class or their professional career. The fact the women were viewed as women first and scholars second caused them to doubt their own worth and questioned their qualification. "It was hard. It was very hard. You doubt yourself a lot. And as a woman especially these guys that are like… It just seems to come so easily to them and…"(TC, professional). Often times, the women projected the sexism they experienced onto themselves and viewed it as a fact of life they had to deal with.

> But the other students (pause) I did, like, I had to prove myself to them. I don't know if it's a (pause) I remember (pause). I remember in my (pause). I remember what class was it, I think steel. I walked in and I got hit on. (JA, professional)

Even though many of the women said that they did not want to be viewed as different because they are a woman, often times they could not avoid it. Peers often treated the women differently than their male peers.

> I feel like I have been treated differently by my peers because I am a woman. I am not sure if it's just because I am quiet so I wonder if that plays a role in the fact that people don't take what I have to say seriously. I don't know I am pretty quiet. Or really considering my opinion valid. I'm not too sure. But I do feel that way sometimes. I am there by myself and then there is that on top of it. It bums me out sometimes but I know I have to snap out of it because it is not going to help anything if I feel that way. I (pause) I have to snap out of it. I just have to just kind of push myself because I know that I can't stay in that mental state that I feel bummed out. And I don't know (pause) I can't stay in that state. I don't know (pause) I know that I have to snap out of it. I feel like I just have

> to change my attitude by the next day. Because it can be (pause) I don't know (pause) sometimes it can be frustrating and it doesn't go away that day but usually by the next day I'll be over it. I'll be fine. (ER, student)

Differential treatment was not just found in the peer group, professors also treated the women differently. Many of the women said that they had professors who "liked girls."

> There was one professor, he was the weirdest professor ever. I just didn't like him. He would say such sexist things to me. And things you are not supposed to say. I've heard that he's had a lot of issues in class and has been in trouble for sexual harassment and stuff like that he's been complaints from other women. As I remember, I asked for 10 graduation tickets and in the middle of the class he's, like, oh she got 10 graduation tickets for her boyfriends, for all her boyfriends. I was like what the heck? In front of everyone he said this… So he was totally sexual harassing students and being inappropriate and [he is still there]. You always make these totally disgusting jokes, like, always on and off like the switches are not nice seeing you don't like Janet Jackson at the Super Bowl. Dr. X. That little mother- fucker. He said you got to be kidding me he said that. [He] is known for being disgusting. And he was just super rude. I could tell and he [could] be so rude to me and cool to the other students. And all the other students like them. But then I was on of this type of guy. He's disgusting. So that is my negative interaction with the professor… Sums it up, I would just let it slide as I was just, like, whatever. But I reported him too. But I would talk to other professors about it and they would say all he said this and they said yeah he's known for that. And that was it. They would say yes he's known for it. He is known for that. I know he got kicked out of (pause) I don't happen what he got kicked out but I could tell something was happening… Blew it off. My professors said, "that's how he is". I think I wasn't treated differently by any other professor. I was an equal to everyone else, suffer with them. I was just engineering student that had to pass a class. He is still there and I wonder why, why haven't they just let him go. (NS, professional)

Finally, in the working world, the differential treatment did not stop. These behaviors could be displayed during an internship or as a professional after graduation.

> At work I get treated differently because I'm a girl. The younger guys especially. They say stuff about me. What is she doing here? What's her purpose?…[There is this one guy at work, he is younger]. He's the one that really tries to get everyone riled up too. About like being boys and he'll beat on his chest and get everyone riled up and they kind of do because they're men so they just go along with it. Even if they don't really want to… [Things are] definitely better with the dads with daughters, they are more understanding. They know how to talk to me. [The way I am treated] makes me feel worthless. It is really disheartening. (PM, student)

Alternative values and expectations

Just like no one asks you how many times it took you to get your driver's license. It's not on there. It just says you finished.(RU, student)

The women all discussed their relationship with grades in college. Most of the women stated that they were good students in high school. This drive for good grades and a high GPA was largely lost on the women by the beginning of their second year in university and was totally lost after their foundational courses in engineering. "It was heartbreaking as I was trying so hard. But I was still unable to get those grades and I had before. It was really hard on me because I was a perfectionist." (SM, professional)

> I'm not sure why I let myself be okay with it [getting lower grades]. I always thought okay- Cs. I could have worked probably better but could (pause) and I just can't expend

> [the time] (pause) I convinced myself that the C was okay. It was never okay before, but I was just okay. I really convinced myself that it was okay and I settled. I settled. That's when I started to settle. (PM, student)

The lack of clear expectations from professors and every changing grading scales made it nearly impossible for the women to know where they stood in class. This was particularly true in the foundational classes, physics, statics, dynamics, and strength of materials.

> There have been classes that I thought I knew what was happening and then I got to the exam and I was like, "what the heck?" so I thought that I knew the study guide and it was nothing like the exam. My professors all give partial credit that is where I get my points from. On exams they usually curve the class. I think sometimes they curve the final grade but not too much. I have thought I was going to get a C+ or a B- and I got an A- in the class. I think it is because everyone else must have done badly. (JG, student)

Not only was there no clear way grades were determined from course to course, there was no way the women felt that they could keep up with the demands of the course or understand what to study.

> We had only ten minutes to complete a quiz every week… It was like one problem but with a bunch of parts… It took me an hour to do each homework problem. There is no way I was going to be able to finish a quiz in a few minutes or even a five question test in one hour. (PM, student)

Not only did the lack of a rationale for grades allowed the women to rationalize their performance in classes, it also predicted their future course of study. Many of the women noted that "it isn't important what my grades are as long as I'm done… I'm not going to go to graduate school" (RU, professional). Even if the women chose to go to graduate school, their GPA could limit their choices "I don't even have a 3.0… There is no way I'll get into a graduate school that is any good" (JB, student).

The role of competition

Competition in the classroom was largely fueled by the discipline's value on intelligence. There was a drive in the field to be at the top of their game. This competition was more exacerbated when the women discussed their interaction with other women. "You would think we would lift each other up… but I wasn't that way. I noticed there was always more competition among the women" (AB, professional).

> The women really did compete with each other quite a bit during classes. It's sad to think that you know most of us were competitive with each other and try to be adversarial to each other not beneficial to each other. (TC, professional)

The competition inhibited the women from making real connections with each other. There were three exceptions to the competition. SR (student) and PM (student) who were friends with each other and VG (professional). VG noted that she had a peer group that all worked together and were supportive of each other. One of the other members of her peer group was a woman.

Dissociation with the process

…stay for one semester and see how it goes. She [a mom where I work] told me I sounded like a battered wife. She said like you are a wife and you keep coming back to that abusive spouse. So it was like I know what you mean… In a sad way that's kinda how it is. I was like that abused wife that kept going back for more it's a horrible analogy but that's kinda how it is that's really how it is (RC, professional).

The women seemed to be largely detached from their academic progress and grades. When the women struggled there is a reason for the struggle such as, "You're never really going to need that again no matter what you study. Doesn't matter what you'll forget it... So why bother learning" (PH, student). Other rationales included "I just knew this class wasn't for me… I just had to take it but it was for the electricals" (KS, professional). There was a variety of reasons the women gave for removing themselves from the process of their education or rationalizing the behavior and expectations of the field. One of the most often cited reasons for detachment from their academic progress in foundations courses was the fact that the women identified as a visual learner.

> The last physics class. The circuits one. But again it's the (pause) I couldn't visualize it and see it. I couldn't visualize what was happening so, I did really bad in that class. I passed by, I think I got a D+ maybe lower but I passed so was check- done. I'm glad it was the class though and not something that I use regularly. (JA, professional)

This detachment to their academic progress pointed to the teaching quality, the abstract nature of the subject matter, and a lack of prerequisite skills.

The women also detached from unrealistic grading expectations and the demands of exams and courses. They understood that no matter what they did, they had little control over their performance.

> It was hard. Like I said, it was virtually, really hard so, I had come to terms with the fact that I didn't pass the class it was not the end of the world I wasn't going to be from a lack of trying. There's not a whole lot to do other than try and use what I was already doing…It's very hard when you're not doing well in a class that you know you can do everything you can. You do everything you can to do well and you're still not doing well. But at the end of the day you still just have to kind of accept it. Such a shift in thinking from high school. (RC, professional)

Professor quality was a common theme among the women as both a way to rationalize poor performance in a course. This was particularly true for foundational courses.

> I never took a programming class and this teacher it was crazy. It was open without prerequisites so I signed up and I had no idea about the teacher or what the class was about... And then he gives us the first test and I sat staring…no idea. It was nothing like the notes. It was nothing like a textbook. It was like nothing in class. You told us in the class on the first day of the textbook but I'm not following… He was skipping the step of the process and writing the code and just going. He was an awful professor. So I didn't know what to do. (RY, student)

It was not only poor performance that the women separated themselves from; a remarkable performance also had an excuse. There were few women who gave their own merit credit for a strong grade in a course. One way the women excused a good grade was that the course was a lab.

> I want to say concrete. I understood a lot of the topics in concrete. I was interested in it. It wasn't necessarily a hard class coming in and had a good professor. Along with the textbook. The textbook you chose how it shows the different processes and steps. It went into detail. It explained different concepts and the way he went about the class and structured it. I think he made it a fairly easy class. I think that I did pretty well in there. I think everyone does well in labs. They are just labs. (JT, professional)

The above excerpt actually points to a few of the reasons women felt they were successful in course, the professor was easy, it was a laboratory, or the textbook was really good. On occasion, the civil engineers also referenced a course being code regulated. This meant that all they had to do was read the code and they could do the assignments.

> I know I did well in timber design. I know I got an A in the class. It could be from a few reasons. A part of it was that there was a project and we had to do a scale model of the house. I also really liked the professor and I knew him really well. You just go through the steps. It's a process. You have these design codes like, I feel you kinda have it down already. So I felt like by that point I feel like that's just another list of codes. (AB, professional)

There were two women in the group who identified themselves as smart and found it within their power to be a success in their undergraduate program. These women were both civil engineers from university 1. When asked, both of these women reflected the sentiment "For this study without being arrogant, I can say I'm just smart" (VG, professional). What is remarkable about both of these women is that they battled a life-threatening disease in high school and throughout their college career. MB explained that, "I was okay with it. I think my mentality changed when I got sick. Everything changed when I got sick. So you appreciate life more you have perspective. I think I had an epiphany when I got sick."

The intelligent few, professors and students who do not work

There was no greater value to the field of engineering than the quality of intelligence. The women all remarked on the brilliance of their professors.

> I will say about the professors I had were very smart. But some of them were so smart they didn't know how to teach it. You know what I mean. They were like too smart and know how to dumb it down. Not dumb it down but make it more approachable or so that people can understand….He was a genius and multiple papers published and it was amazing blah, blah, blah, but do you know how to teach it. He was like, oh, yeah, it's Tuesday and he just happened to know it's Tuesday but he didn't explain why things are happening. You just kind of give it to you and you would just like okay. (SM, professional)
>
> And our teacher… He is a concrete genius. He has won a ton of awards in concrete design related fields so… I really liked that teacher and I could always ask him questions and he was one of the nicest teachers I had. I really liked that class. (KS, professional)

The identification of the brilliance of their professors made the women feel as though the professors were unapproachable. This also sets up a strong power dichotomy, in which information was given to students and the level of brilliance cannot be reached. Not only was a differentiation between the student and professor reinforced, but an excuse for bad teaching is granted. Many of the women spoke about their professors being too smart to make the subject matter approachable.

> I don't usually ask professors questions. Usually I think that my question is dumb, or something that I should already know. A lot of our professors are intimidating about that. It might be just me. But a lot of our professors are foreign-born so they have accents so I can't really understand them sometimes. So I don't want to ask a question that I should have already known. (JG, student)

Brilliance did not stop at the professors. The women projected an air of brilliance on some of their classmates.

> There are three kids that sit in the front and are the smart kids. They are all men. The always ask the right question at the right time. Sometimes they will even stump the teacher. Sometimes they just know what to ask. They just always have the answers, they participate, they ask the right questions and get the A+s on the exams. I keep more to myself. I don't really like to speak out. (JG, student)

This perceived brilliance was possibly more daunting for the women. The students showed that the level of proficiency demanded by the department is achievable. TC described the relationship with the "smartest" student in her department.

> And as a woman especially these guys that are like (pause). It just seems to come so easily to them and (pause) it just used to make me so angry. (pause) There are always those student who wreck the curve of the rest of us. (TC, professional)

Alternative ways to show mastery: Laboratory

As long as I can explain the topics. As long as I knew I learned something then I felt successful… Lab is where I applied my knowledge. (JT, professional)

The role of the laboratory classes in undergraduate engineering programs was huge for women. The women all found a sense of success in the lab classes. They saw the classes as a way to apply their knowledge and demonstrate their understanding of the material. Not only did they have a sense of validation in laboratory classes, but they were also a connection to the abstract concepts proposed to them in lecture.

> So my grades have changed since I was in high school. I would say that I am more accepting of my grades. In high school it was really rare to get a B and I thought that that was devastating enough. Then I came here and I had to accept lower grades because my classes are harder. I have just realized that the grades aren't everything and I just have to understand the material. And so now I am taking classes that I want to take and my grades aren't the only measure. The tech electives and upper division classes are different. We can say that I know the material even if my grade doesn't reflect that- like I will get a B or C in lecture and an A in lab I am still proving that I know the material. (RA, student)

Even though the women felt successful in laboratory classes, there was still a sense that the accomplishment was no big deal. The understanding that everyone did well in laboratory classes seemed to be a wide accepted fact. "I don't think that anyone doesn't do well in lab" (PH, student).

Alternative ways to show mastery: Networking

Professionally, the women detached themselves from their grades very early. The women found validation for their learning and gathered a sense of worth in their professional clubs.

> The professional clubs ASCE and ITE at the student level. Because that is where you get to go to these big conferences and meet engineers, and they're not super social but they are. When you think of engineers you think of all the stuffy nerds but you meet them and you realize that they're real people. And you meet their wives. And you see wives look at you like… What? I was respected by them. I was valuable. (RU, professional)

Even though they were not seeing the type of grade outcomes they would have liked, they were still receiving offers of employment and were sought after early in their undergraduate career. This validation made the grades they were receiving inconsequential relative to the goal of employment upon graduation.

> I met my first boss at a conference. I never looked back after that. The networking really helps me because I knew so many people in the industry that if I would to lose my job tomorrow I don't think that I would be out of a job for too long. I don't feel like I would be lost. I could pick up the phone and call one of the hundreds of contacts I made as a student. Maybe I wouldn't get a job the next day, but I would be steered in the right direction. (TC, professional)

Theme 3: Outcome Expectancy

Lent et al. (2003, 2007, 2008) showed that outcome expectancy was a driving factor for students entering and persisting in the field of engineering. While this fact largely remained true for the women in the study, the context was quite different. The women had goals for performance along the way to a degree, which were reinforced by the qualities the field values. The women also used the promise of a secure future to justify the unrelenting demands of the degree and the behavior of their professors and peers.

Goal of procedural proficiency and efficiency

The ultimate measure of the worth of an engineer was that they are efficient in their process, proficient in their calculations, and intelligent enough to handle any problem they were faced with. The discourse within the field supported this notion.

> This is a foundational course… Do not take it lightly. I have said it in previous courses so I must mention it here too. Statics is a fundamental course. Not just because I am teaching them. However, it is so important that anyone who gets an A in statics, I can guarantee. I can give you a signed signature that he would be a good engineer, a successful engineer. Because it is so important to grasp the principle that you are set up already for the much more difficult classes. (Statics professor)

Many of the women stated that their university had prepared them for work "I would say my school over other schools really prepares you to work. You have a lot of opportunities to really get experience to go join teams and doing hands-on experience in classes" (KC, student). This however was limiting. The procedural knowledge did not prepare students to be creative or inventive with their thinking, nor did it prepare students for graduate school.

> If you want to go to grad school you don't have anything to back that up. You don't have any research [from your courses]. You have to go out and really succeed on your own research project and shadow professor so the research is part of [your extra-curricular program] so it is really hard to go to grad school [the way the degree is structured]. (KC, student)

The women were left with a string of unconnected classes and skills that make up their knowledge of engineering.

> I think if we had taken the time to be a little more well-rounded back in the day I think you would've benefited us as individuals [sic]. But for us, it was just a machine. It was like an assembly line. It was one difficult class after next technical class after the next difficult class. I think that's why I like the water classes so much because they were different. There was like three or four of them and they all fit together. You can see the whole picture. Versus going from structures to thermo to a lecture and never flowed together. You never saw what it meant. (VG, professional)

Doing something

Now that I am in the private sector I take my team of white men with me to pitch a job and I know we don't have a chance against a public agency. The public agency is more inclusive. They have more

stakeholders to answer to so the agency tries to reflect that. In a public agency you are valued for being different and representing a different group. (VG, professional)

The notion of doing something with your degree was a common theme the women express. This humanitarian drive to obtain a degree followed Cech's (2014) work that showed a culture of disengagement among engineers caused women to leave the field.

> I just want to be impacting the world in a bigger way. I want to make a difference. It seems kind of weird to say but... In transportation you're moving people and that's important. Usually the highways make things better. If I could have the perfect job would probably be traveling to low income societies and helping build infrastructure. (SR, student)

Not only did the women feel like they wanted to "do something" with their degree, they also understood that working for public agencies extended the length of their career.

> Most definitely. [Working for the public agency lengthened my career in engineering.] The difference being that I have very diverse experience in a very diverse career path. Working in the public sector I got opportunities at a young age that I never would've gotten a private agency. I never would have gotten [those experiences] in the private sector. Also the roles that I took on. And by falling into the water recycling there were very few people were working on that at the time. (VG, professional)

Finally, the women saw a second career in humanitarian fields after they worked as an engineer. Many of the women pointed to teaching as a second career.

> Something to do with the engineering industry but I think eventually go more the teaching route or something like that. That's something that I really enjoyed something to doing instead of engineering. This is something I really like to do at the college level (pause). I could be a Solid Works teacher or something like that. It would be more like the teaching lines. Not design work forever for sure. (RC, professional)

Security as a liberator and excuse maker

Security of outcome could be examined from two sides of a coin. The women had made tradeoffs in their undergraduate time with the anticipation that they would have a good paying steady employment when they finished their degree. "For the rest of my life I get to say that I'm an engineer. And the name recognition that goes with that is unparalleled" (JB, student). It was not only the prestige of the degree that allowed the women to feel secure. "It's very stable and well-paid good job. A lot of my friends that were other majors can't find jobs. I've been in school six years, but I know I'll have a secure job when I graduate" (PM, student).

The security of employment and long term stability was not a trend that only the women experienced. Many of the women noted that the security of employment extended to the professors.

> [My professor], He was just a great person… He was financially secure. So it gave him the liberty to really invest in the relationships with students. As opposed to looking for the next thing. He wasn't always stressed or worried about trying to make a connection to get something else… Once folks become financially independent that takes away that burden. It takes away a layer of concern or fear word anxiety and it really just opens you up to the possibilities- to experimenting. (VG, professional)

Regardless of their status, professor, graduate or undergraduate student, all of the groups were motivated by an anticipated secure outcome. It allowed the women in the study to persist when they felt like giving up and justified the sacrifice they had made during their undergraduate

career. The experimentation that was allowed by security worked as a balancing force against the procedural proficiency the field demands.

Findings and Implications

This research provides a set of baseline data for university engineering programs to begin to make policy and teaching changes in the field of engineering. These findings explore the unique experiences of women at public universities. The results provide a justification for collaboration between public agencies and the university engineering departments. This can take a variety of forms: internships, smaller community service projects, service learning, or a course that connects the student with authentic undergraduate experiences in engineering.

Theme 1: The Journey of a Cultural Migrant

The Journey of a Cultural Migrant was the first theme that emerged from the data. This theme was focused on the phases of migrant integration used widely throughout the literature and UNESCO (2017). As indicated by Seymour [6], Cech et al. [7] and [17], and Marra [4] women are entering a field that is not traditionally for them. That is to say, the women were entering an educational path that is typically male. Approaching this journey through the lens of a migration to the field allowed for a deeper level of understanding of the journey the women travel. In this study, the women fit the description of a migrant as defined by UNESCO, a person that chooses to leave their current life for another and changes their social ties (2017). While this path may seem like it could apply to their male counterparts, the women in the study specifically noted that they are entering a society in which they are the minority- not the norm. They felt as though they must conform to their male counterparts.

Migrants integrate to a society in a variety of stages. The first stage the women experienced was an early exposure to a STEM career. This was through three main categories of exposure: a parent with an engineering degree, an enrichment science experience when they are young, or a course designed to engage students in high school. This early exposure to the field acted as an admission ticket- a permission to enter- to the field. This early exposure was consistent with Hughes and Hurtado [19] who noted that the preparation of students was a key factor in persistence. After the women made the decision to enter the field, they felt that they were leaving one life for another. This mismatch of expectations from the previous life and current field of study is reflected in both Cech [17], who, noted that the demands of the field are often incongruent with the demands of family life, and Capobianco [18], who showed that the identity of an engineer surpassed gender identity for those who persisted in engineering.

In this study, the women left their current life styles and friends to bend to the demands of the field. This was supported by the next category within the theme, learning new cultural norms. Pawley [23] reflected how language in foundational classes formed a way of being in engineering courses. In order to navigate these norms, the women built a structure of social support within the field. This social support gave the women a sense of empowerment and belonging, although they rarely identified these groups as their friends. Even when they did identify these groups as friends, later in the interview the women often said that their friends were outside of engineering or that they had no friends. Their social networks were largely transactional. This social network took two forms, a peer group and professional clubs. Even the associations with professional clubs changed as the women navigated their undergraduate program. For many of the women, they began in cultural or gendered clubs and migrated to

professional societies as they gained more knowledge of their discipline. The importance of a social network was studied by Chesler et al. [33], Cross et al. [8], and Cairncross et al. [26] to mention a few; all these authors pointed to a social network within the field of engineering as a resource that allows the women to feel accepted in the field.

Finally, like many migrants to a foreign land, the women had one foot in the field of engineering and one foot in their previous life. The women had conformed to the norms of engineering and perform engineering tasks; however, they met the norms with an air of defiance. This dual identity provided a fluid space for the women to travel across borders. Logel [34] showed the struggle of dual identity that women faced when they became an engineer. This theme took all the indicators that had been dealt with in isolation and provided a synthesis of the process to make sense of the journey.

Implications of Theme 1

- To attract women and URM groups that do not have the social capital to experience early exposure to engineering, increase funding for policy initiatives that work on early outreach in STEM. This means connecting all students with authentic STEM experiences at an early age and sustaining this contact.
- Traditional meeting times for professional and support clubs miss the non-traditional engineering student and can conflict with each other, meeting time should be varied to reach more students.
- Support peer and faculty mentoring of students entering engineering programs. This means connecting women with academic and social resources and following up regularly on student progress. This support should not be one size fits all but should work to mentor women students from the community college as well as the k-12.
- Help to foster the formation of peer groups in foundational courses, this can be formally or informally. This will help women build a sense of identity within the field.

Theme 2: Negotiating Comparative Norming

The second theme that emerged from the data is largely a result of the theoretical framework that informed the study. Weedon gave the four pillars of feminist poststructuralism as: Language and Discourse, Subjectivity, Power, and Common Sense [21]. Primarily, the theme drew from the subjectivity that the women encountered during their undergraduate career. This subjectivity had been indicated by some of the participants to extend to the professional arena. Subjectivity is defined as "the conscious and unconscious thought and emotions of the individual, her sense of herself and her ways of understanding her relation to the world" [21, pg. 32]. Weedon continued that subjectivity is "precarious, contradictory and in process, constantly being reconstituted in discourse each time we think or speak" [21, pg. 32].

As a woman, the participants in the study were at the intersection of these ways of being and understanding. "Subjectivity relies on the marginalization… of alternatives" [21 pg. 87] and is an ever changing lens through which the women defined their place in the field. The theme called attention to the fluid sense of knowing; Negotiating Comparative Norming. This theme arose from categories that addressed the avenues through which the women made meaning and understood their place. This began with the development of a situated identity paired with alternative values and expectations of the field. The reaction of the others in the field gave rise to

the role of competition. To cope, the women dissociated with the process and were unable or unwilling to take ownership of their success or failures in the field. The women projected onto others an aspirational hope of intelligence with the next category, the brilliant few. To combat the fact that the women did not view themselves as one of the "smart ones" and their lack of successful academic progress, the last two categories with theme two that arose: alternative ways to show mastery- laboratories and alternative ways to show mastery- professional clubs. The clubs and labs provided the women an outlet to express their learning and understanding of the material. The fact that many of them were offered internships early in their college program (in part because of their gender) made it ok to not be the smartest or get the best grades. Finally, the laboratory courses in which the women were successful were devoid of the language and discourse the women exist within in the lecture sections. The problem solving, applied nature of the labs allowed the women to work outside of the discourse of the classroom.

It would not be uncommon for men and women to struggle in their engineering courses. In fact gate-keeper courses typically have a staggeringly high number of failures for both genders. However, men and women typically react differently to the struggle. As indicated by Hill et al [9] and Marra et al [4], women's self-confidence takes a drastic plummet after the first year of study in an engineering program. After this first year the level of confidence does begin to rise, but it will never reach anywhere close to its initial level stated that at this point women begun to compare themselves "unfairly" with their male counter parts and with unrealistic expectations of success [4]. This time is when the women are entering into their design based classes. Their male counterparts are at a high level of confidence in their ability, and the women become entrenched in self-doubt. The subjectivity the women face, leaves them lacking confidence at a rate much greater than their male counterparts.

Implications of Theme 2:

- Increase the laboratory experiences of students and begin engineering labs early in a student's program.
- Attach in-class laboratory-like experiences in gatekeeper courses such as Statics and Dynamics.
- Set guidelines for grade attainment in all courses. This is guided by clear grading rubrics and smaller formative assessments that allow students the opportunity to make judgements about their progress on the course material.

Theme 3: Outcome Expectancy

Studies by Lent et al. [13], [14], [31], Cech [17], Klotz et al. [35], and Diekman et al. [36] all informed the final theme for the entire data set. Lent et al. [13], [14], [31], proposed Outcome Expectancy as a factor that positively impacted student persistence as part of the Social Cognitive Career Theory (SCCT). Where this study looked just at the promise of a positive outcome, success in class or graduation with an engineering degree, this theme addressed the long term outcome for the women as a driving factor in their persistence. The women were driven to persist in their undergraduate program by the benefits that an engineering degree could provide them in their future.

The first category of the theme 3 reflected Cech's [17] work that showed a culture of social disengagement as a reason women left the field. This was extended with Diekman et al. [36] that showed an incongruence between outcomes of engineering and the roles women played in the

field as well as extends the dissociation with the field. The category reflected the women's desire to do something humanitarian with their degree after they leave college. This could have meant something such as developing green technology, building infrastructure, or making advances in polymers to use in various consumer products. Not only were the women driven by egalitarian motives, but also by the long term security an engineering degree could provide them. This certainty of outcome and long-term sustainability allowed the women to have a temporary trade off of desires for a social life and family for the demands of the undergraduate degree program.

Implications of Theme 3:

- Fund graduate programs in engineering such that programs encourage women and URM groups to enter. This would increase the number of female and minority full-time professors at universities and create role models for future students.

Implications for Research

The field of engineering rarely examines itself with a qualitative methodology. This lack of qualitative research has led to a reliance on causal assumptions and focused the field on indicators for persistence with little explanation of the reasoning behind the findings. This study provided a good foundation to extend the study of women in the field of engineering or any other marginalized group of students. The study also examined first-generation engineering students as well as students who transfer from community college to a four-year public university engineering program.

The intersection of gender, with the discipline of engineering is an area that needs to be explored further than this study to make more generalizable results. The focus on institution type of this study and a staged approach allows for a more complete understanding of experience of women in this system. Similar studies could be replicated to study different university types, or specific disciplines within the field. To extend these findings a larger group of women should be studied making certain to reach more African-American women in particular. Further studies should also examine the experiences of women in undergraduate engineering programs by discipline within the college of engineering.

Study Limitations

The sample of the study limited the generalizability of the finding. The study focused on two public universities in California that have ABET accredited undergraduate engineering programs. It only examined the experience of women in their undergraduate degree program. Those women who have completed their degrees may or may not have entered a graduate degree program. The solicitation of the women to participate in the study was also limiting. The undergraduate women were solicited through email from postings on professional societies at the universities or conference proceedings. The graduates were located by a variety of avenues. Some of the women were contacted by a mutual acquaintance who knew of the research and pointed the researcher in the direction of a woman for the interview. The majority of the women were located by the universities websites as notable alumni or by contact with local engineering firms. The study had only one participant who was not involved in a student group. This involvement changed the experience of the women as indicated by the research. Finally the mix of ethnicity and discipline was limited. There was only one African-American woman in the study and one chemical, one industrial and two electrical engineers. This small number did not allow for a disaggregation of the group on these characteristics.

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