LIVING-LEARNING COMMUNITIES IN COLLEGE:

OUTCOMES FOR WOMEN IN ENGINEERING

by

ELLEN SUE LIEBERMAN

A dissertation submitted to the

Graduate School-Newark

School of Public Affairs and Administration

Rutgers, The State University of New Jersey

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

Graduate Program in Urban System: Global Urban Studies

written under the direction of

Alan Sadovnik

and approved by

____

____

____

____

Newark, New Jersey

May 2018

ABSTRACT OF THE DISSERTATION

Living-learning communities in college:

Outcomes for women in engineering

By ELLEN SUE LIEBERMAN

Dissertation Director:

Alan Sadovnik

Abstract

Women remain underrepresented in most science, technology, engineering, and math majors in college (STEM). A survey of first year students at all four-year colleges in the U.S. indicated that only six percent of women intended to major in engineering (National Science Foundation, 2017). Undergraduate programs for women in engineering are important for the labor force.

Using a mixed method design, this study examined the recruitment, retention, and academic achievement of students in engineering at a large, public research university between fall 2012 and fall 2015. Through a case study of a women's-only living-learning community (LLC), the experiences and outcomes for students in engineering were assessed. Data were obtained via semi-structured individual interviews and from student records. Using Eccles' model of expectancy-value motivation theory, Astin's theory of student involvement, social capital theory with how capital enables social networks to develop, the study examined the effects of a women-only LLC on the recruitment, retention, and academic achievement of engineering students; and the experiences of participants in the women-only LLC including its strengths and weaknesses.

Results showed a significant increase of women entering engineering (24%) in the four-year period, despite a two percent overall engineering enrollment decline. High School Grade Point Average (HS GPA) and Scholastic Aptitude Test (SAT) Math Scores were significant factors predicting retention and engineering grade point averages. Gender and race/ethnicity were not factors in predicting engineering retention or achievement. LLC women entered college with the lowest combined SAT scores of the comparison groups. However, for both years one and two they earned the highest engineering GPA and had the highest retention rate.

Themes of community, friendship, and peer encouragement created a strong and resilient social network. Connections to resources and access to faculty, especially women engineering faculty, were strengths of the community. A required Women and Gender Studies course was important because it was not engineering-related and offered small group discussions about global issues affecting women. Weaknesses of the LLC were feeling disconnected from non-engineering students and less involvement in non-engineering activities. Based on prior research of Living-Learning Communities, this study is a contribution to the field.

Table of Contents

ABSTRACT OF THE DISSERTATION .... **ii**

ACKNWLEDGEMENTS .... **x**

DEDICATION .... **xii**

CHAPTER 1: BACKGROUND OF THE STUDY **1**

1.1 INTRODUCTION 1
1.2 PROBLEM STATEMENT 3
1.3 RESEARCH RATIONALE 7
1.4 PURPOSE OF THE STUDY 8
1.5 SIGNIFICANCE OF THE STUDY 9
1.6 THEORETICAL FRAMEWORKS AND RESEARCH QUESTIONS 10
1.7 CONTRIBUTION TO THE LITERATURE 12

CHAPTER 2: LITERATURE REVIEW **14**

2.1 INTRODUCTION 14
2.2 THE EDUCATION OF WOMEN 14
2.2.1 Women's Historical Access to Education 14
2.2.2 The Role of Women's Colleges 17
2.3 COLLEGES GO COEDUCATIONAL 18
2.3.1 Colonial Colleges Follow Suit 20
2.4 EQUAL OPPORTUNITY IN PUBLIC EDUCATION 21
2.5 ACCESS DOES NOT EQUAL REPRESENTATION 22
2.6 WHY CHOOSE ENGINEERING 23
2.7 WHY THEY LEAVE ENGINEERING 24

CHAPTER 3: THEORETICAL FRAMEWORKS **31**

3.1 INTRODUCTION 31
3.2 MOTIVATION THEORY: EXPECTANCY-VALUE 31
3.3 EFFICACY AND COLLECTIVE IDENTITY 33
3.4 SOCIAL CAPITAL THEORY 36
3.4.1 Bonding, Bridging, and Linking Social Capital 39
3.4.2 Bourdieu's Theory of Social Capital 40
3.4.3 Putnam and Mutual Reciprocity 43
3.4.4 Coleman's Normative Behavior Theory 45
3.4.5 Granovetter: Weak and Strong Ties 47
3.4.6 Social Needs Perspective 49
3.5 LIFE COURSE PERSPECTIVE 50
3.6 SOCIAL CAPITAL, SOCIAL NETWORKS, COHESION, AND LIVING-LEARNING COMMUNITIES 51
3.6.1 Social Cohesion 52
3.6.2 Social Networks 53
3.7 STUDENT INVOLVEMENT THEORY 56
3.8 SUMMARY OF THEORETICAL FRAMEWORKS 57

CHAPTER 4: RESEARCH METHODS AND DESIGN 60
4.1 RESEARCH SETTING 60
4.1.1 About Rutgers 60
4.1.2 When Women Were Admitted to Rutgers 60
4.1.3 Rutgers Today 61
4.1.4 School of Engineering, Rutgers – New Brunswick 61
4.1.5 Douglass, the Women's College at Rutgers 62
4.1.6 The Douglass Project for Women in STEM 63
4.1.7 Living-Learning Communities at Douglass 64
4.1.8 The Women-Only Engineering Living-Learning Community 65
4.2 AREAS OF INQUIRY 67
4.3 RESEARCH DESIGN 68
4.3.1 Quantitative Design 68
4.3.2 Qualitative Design 69
4.3.3 Human Subjects 72
4.3.4 Data Sources 72
4.3.5 Sample 75
4.4 STATISTICAL ANALYSES 76
4.5 ROLE OF THE RESEARCHER 77

CHAPTER 5: QUANTITATIVE RESULTS 80
5.1 INTRODUCTION 80
5.2 DATA COLLECTED 81
5.3 PARTICIPANT PROFILE 82
5.3.1 Student Demographics 83
5.4 INTENDED MAJOR 87
5.4.1 High School Academic Achievement 90
5.5 ENGINEERING RETENTION 95
5.5.1 Retention Year One 96
5.5.2 Retention Year Two 99
5.6 ACHIEVEMENT OUTCOMES (GRADE POINT AVERAGES) 102
5.6.1 Achievement Year One 102
5.6.2 Achievement Year Two 106
5.6.3 Intended Engineering Major 111
5.6.4 Ethnicity/Race 112
5.7 SUMMARY OF IMPACTS 112
5.7.1 Recruitment Outcomes 113
5.7.2 Retention Impact 114
5.7.3 Academic Outcomes 116

CHAPTER 6: QUALITATIVE DATA ANALYSIS 118
6.1 INTRODUCTION 118
6.2 DATA COLLECTION 118
6.3 ANALYSIS OF STUDENT INTERVIEW DATA 119
6.4 PARTICIPANT DEMOGRAPHICS 120
6.4.1 Race/Ethnicity 120

6.5 YEAR OF ENTRY 121
6.6 TYPE OF HIGH SCHOOL 122
6.7 INTEREST IN ENGINEERING 122
6.7.1 Motivation to be an Engineer 122
6.7.2 Perceived Skill in Math or Science 124
6.7.3 Enrichment Programs 127
6.7.4 Influence by Family and Teachers 130
6.7.5 Encouragement by a Teacher 133
6.7.6 Did They Feel Prepared? 134
6.8 WHY RUTGERS AND DOUGLASS RESIDENTIAL COLLEGE 136
6.8.1 Selecting Rutgers University – New Brunswick School of Engineering 136
6.8.2 College Costs 139
6.8.3 Influence of Friends and Family 140
6.8.4 Why Douglass and the Engineering Community 141
6.8.5 Anticipated Support 142
6.9 WHAT THEY EXPERIENCED IN THE COLLEGE 149
6.9.1 Social Experiences 151
6.9.2 Community 152
6.9.3 Friendships 155
6.9.4 Layered Mentoring 157
6.9.5 Engineering Explorations 160
6.9.6 Faculty Support 162
6.9.7 Staff Support 164
6.9.8 Co-curricular Activities 166
6.10 OUTREACH AND RECRUITMENT 169
6.11 OUTCOMES: MOTIVATION 170
6.11.1 Motivation to Persist 170
6.11.2 Feeling Valued 173
6.11.3 Peer Support 175
6.11.4 Faculty Support 176
6.11.5 Self-motivated 178
6.12 DIFFICULTIES 186
6.12.1 Barriers for Women in Engineering 186
6.12.2 Diversity Awareness and Racial Discrimination 186
6.12.3 Gender Discrimination 188
6.12.4 Sexism 193
6.12.5 Self Confidence, Doubt, and Low Self-Efficacy 194
6.13 PERCEPTIONS OF OTHER ENGINEERING STUDENTS 198
6.13.1 Men in Engineering 198
6.14 INCLUSIVITY 199
6.15 OVERALL OUTCOMES FOR WOMEN IN ENGINEERING 202
6.15.1 Empowered and Educated 202
6.15.2 Accepted and Supported 204
6.15.3 Promoted Student Retention 205

6.16 Feedback and Advice ... 209
6.16.1 Most important aspects of the Living-Learning Community ... 209
6.16.2 Perceived Weaknesses of the Engineering Community ... 216
6.16.3 Advice ... 217
6.16.4 Keep the Community ... 217
6.16.5 Suggestions for Improvement ... 219
6.17 Summary ... 223
6.17.1 Demographic Data ... 223
6.17.2 Motivation for Engineering at Rutgers ... 224
6.18 Experiences and Outcomes ... 225
6.18.1 Student Engagement in Curricular and Co-Curricular Activities ... 225
6.18.2 Difficulties ... 226
6.18.3 Supports Contributing to Engineering Retention ... 227
6.18.4 Advice ... 229

CHAPTER 7: DISCUSSION AND RECOMMENDATIONS ... 234
7.1 Background ... 234
7.2 Research Design Overview ... 236
7.2.1 Persistence ... 237
7.2.2 Academic Achievement Outcomes ... 239
7.3 Race/Ethnicity of R-DELLC Students ... 239
7.4 Research Questions Aligned to Outcomes ... 239
7.4.1 LLC Impact and Outcomes on Recruitment ... 241
7.4.2 Impact of LLC on Retention of Women in Engineering ... 242
7.5 Academic Outcomes ... 243
7.5.1 Experiences of LLC Members ... 245
7.5.2 Weaknesses of the LLC ... 246
7.6 Theory and Outcomes ... 246
7.7 Limitations ... 256
7.8 Recommendations to Higher Education Administrators ... 262
7.8.1 Living-Learning Communities Engender Involvement ... 262
7.8.2 Supportive Environments ... 263
7.8.3 Inclusive Spaces ... 263
7.9 Strategies for Helping Women Become Engineers ... 264
7.9.1 Visualizing the Future as an Engineer ... 264
7.9.2 What Engineers Do ... 264
7.9.3 Cohesiveness and Identity ... 265
7.10 Advice to Administrators ... 266
7.11 Recommendations for Future Research ... 267
7.11.1 Need for Additional Data ... 267
7.11.2 Intended and Declared Majors ... 269
7.11.3 Gendered Differences in Learning ... 272
7.12 Conclusion ... 273

APPENDIX A ... 296

APPENDIX B ... 307

APPENDIX C **308**
APPENDIX D **309**

List of Figures

Figure 1. National Data of First Year College Students Intending to Major in Engineering , 1998-2014.. 4
Figure 2. National Data on Intention to Major in Engineering (2007) versus Degree Completion (2013) by Gender 6
Figure 3. Comparison of Bachelor's Degrees Awarded in the U.S. by Gender in 2014..... 7
Figure 4. Overview of Expectancy-Value Motivation Theory 32
Figure 5. Change in Enrollment Count, 2010-2015... 85
Figure 6. Box Plot Quartile Distribution of High School GPA by Student Type............. 92
Figure 7. Box Plot Quartile Distribution of Combined Verbal/Math SAT Scores........... 94
Figure 8. Retention in Engineering at the End of Year One by Student Type 97
Figure 9. Engineering GPA by Student Type, End of Year One.................................. 103
Figure 10. Engineering Year Two GPA by Student Type.. 107

List of tables

Table 1. Research Questions Aligned to Theory and Literature 12
Table 2. U.S. Higher Education Institutions 1870-2015 19
Table 3. Enrollment of First Time Students in Higher Education (U.S.) by Gender 22
Table 4. Research Variables and Data Sources 73
Table 5. Total Enrollment of First-time, Full-time Men and Women in Rutgers School of Engineering, Fall 2012 through Fall 2015 by Gender 76
Table 6. Characteristics of the Study Subjects 84
Table 7. Distribution of Intended Engineering Majors for Incoming (First Year) Students, Fall 2012-Fall 2015 87
Table 8. Distribution of High School Grade Point Average 91
Table 9. Distribution of Combined SAT Math and Verbal Scores (SAT) 94
Table 10. Retention in Engineering End of Year One 96
Table 11. Retention in Engineering Year Two by Student Type 100
Table 12. Binary Logistic Regression Engineering Retention Year Two 101
Table 13. Distribution of Engineering GPA, End of First Year 104
Table 14. Linear Regression Engineering GPA Year 1 105
Table 15. Distribution of Engineering GPA, Year Two by Student Type 108
Table 16. Linear Regression Engineering GPA Year 2, All Control Variables 110
Table 17. Motivation for Engineering Major, Rutgers, and Douglass LLC 124
Table 18. Social Experiences 151
Table 19. Research Questions Aligned with Methods and Data Source 240

ACKNOWLEDGEMENTS

Blessed are you, who gives life, sustains us, and enabled us to reach this day. A kind word, a smile, or encouragement changes the course of a person's day – or their life. Many people inspired and guided me. To those who mentor me and supported my efforts, thank you. My mother, Leatrice Newman Lieberman's love and advice pushed me to be my best, and reminded me to - "stop playing around and get your work done."

My children, Nikki Elise (Schreihofer) Sharoupim and Kenneth Anthony Schreihofer, III, were a source of strength and help. Ken, you were the ultimate MOUS-boy and I remain grateful for your encouragement and help. Our conversations about higher education are fun. Nikki, "she believed she could, so she did." It is exciting to share a passion for psychology and educational systems with you. Your help with qualitative/thematic coding and directing me to resources was important. Your support and encouragement kept me motivated. Dr. Peter Sharoupim, your compassion, humor, and regular supply of bubble tea gave me the inspiration and energy to keep going! Kristin and Ksenia, thank you for being the "cheering section" and for regularly saying, "You got this." You were encouraging, and caring. I look forward to the many ways we will grow, learn, and laugh, together. And, I can't wait to meet (baby "K")!

Thank you to my amazing and exceptional committee: Dr. Alan Sadovnik (chair), Dr. Jeffrey Backstrand, Dr. Dula Pacquiao, and Dr. Rubab Qureshi who provided guidance, encouragement, assurance, and assistance. Alan, your tireless support and mentorship was a grounding force throughout every stage of my doctoral career – and through the many life events. Thank you for being the chair of the committee. You were a pillar of strength. Jeff, your patience, humor, and time commitment was so important to me. You were always calm and encouraging. You shared your expertise, which made everything possible. Your willingness to answer a multitude of questions put me on the correct "data path." Dula, your passion for the social determinants of health sparked my own commitment to the doctoral program. I respect your work and I am grateful that you have included me. Rubab, your Nvivo advice and your kindness kept me motivated.

To my family, friends, and colleagues your encouragement and interest in my progress was uplifting. Thank you for your patience and understanding with the many years of my doctoral work. Dr. Phil, thank you for golf, palace and support! Eileen, Bob, Kiersten, & Sean, thank you for sharing adventures with more to come!

Dr. Jacquelyn Litt and Dr. Thomas Farris, thank you for your vision in creating a living-learning community for women in engineering. Your commitment to inclusive learning spaces is critical in creating a more diverse classroom and workforce. The staff and faculty in School of Engineering make a daily difference to all students and especially to women in engineering. I am grateful to my colleagues at Rutgers University – New Brunswick who helped in many ways including providing the data and answering questions. To the students in the Reilly Douglass Engineering Living-Learning Community, I am indebted for your support and contributions to this research. For all women in the School of Engineering - persist. Your perspective is important.

And, to Dr. Barbara Tocco, thank you for providing clarity and encouragement. You helped guide me through difficult times. Vinny offered levity when most needed. I'll admit that the pack is lighter - even with two hoods. Next time I'll reference check the Sherpas. One day, when I am President, I hope that we will continue our conversations.

It was all curious and interesting – as was this journey.

Dedication

To my mom (of blessed memory), Leatrice Newman Lieberman; and,

to my children, Nikki Elise and Ken III --

You are the reason.

Chapter 1: Background of the Study

I'm Gonna Be an Engineer by Peggy Seeger

…When I went to school I learned to write and how to read
Some history, geography and home economy
And typing is a skill that every girl is sure to need
To while away the extra time until the time to breed
And then they had the nerve to say, What would you like to be
I says, "I'm gonna be an engineer!"

"No, you only need to learn to be a lady
The duty isn't yours, for to try and run the world
An engineer could never have a baby
Remember, dear, that you're a girl"...

…I've been a sucker ever since I was a baby
As a daughter, as a wife, as a mother and a dear
But I'll fight them as a woman, not a lady
I'll fight them as an engineer!...

(excerpt from "I'm Gonna Be an Engineer, Words and music by Peggy Seeger in 1970, Copyright Stormking Music, Inc., Recorded by Frankie Armstrong- Out of Love, MacColl & Seeger – At the Present Moment. Used with permission)

"I feel like women bring a different way of thinking about engineering, and I feel like since more and more of us are in the field, I really think this world is going to prosper because engineers built the world. Because, we just think in a different way, I feel we can open doors that haven't been open before."
(Penny M., student,
Reilly-Douglass Engineering Living-Learning Community, 2017)

1.1 Introduction

Data collected by the National Science Foundation (2017) identified over 20 million students, worldwide, earned bachelor degrees from a college or university in 2012. Of the total number of undergraduate degrees awarded around the world, approximately six million were in the sciences and engineering areas (National Science Foundation, 2017).

In many countries, the proportions of undergraduate degrees in the sciences and engineering were higher than those earned in the United States.

More than half of all first university degrees in the sciences and engineering were earned by students in Asian colleges and universities as compared with about one-third of students in the United States earning a degree in the sciences or engineering. The Asian universities therefore accounted for almost four million of the world's six million science and engineering first degrees; almost 50% of them were engineering degrees. Students on the European continent (including Eastern Europe and Russia) accounted for more than one million of the science and engineering degrees with approximately one-third of them in engineering. And, students on the North American continent earned almost 800,000 degrees in science and engineering in 2012 with only about 20% in engineering. Specifically, in the United States, about five percent of all Bachelor's degrees in 2012 were earned in engineering (National Science Foundation, 2017).

Women in the United States have not entered the science and engineering majors at the same rate as women in other countries. The majority of degrees awarded to women in the United States were in social and behavioral sciences. In many other countries women earn more than half of the bachelor degrees in the sciences and engineering. In the Middle East, women earned approximately 50% of the science and engineering degrees in almost all of the countries in that area. Similarly, in Singapore and Colombia, approximately half of all degrees in the sciences and engineering fields earned by women were in engineering. In Asia, women earned about one-third of degrees in science and engineering. There were high proportions of women in other countries that earned their first degree in engineering: Malaysia (31%), South Korea (31%), Finland (28%), Taiwan (28%), and India (27%) (National Science Foundation, 2017).

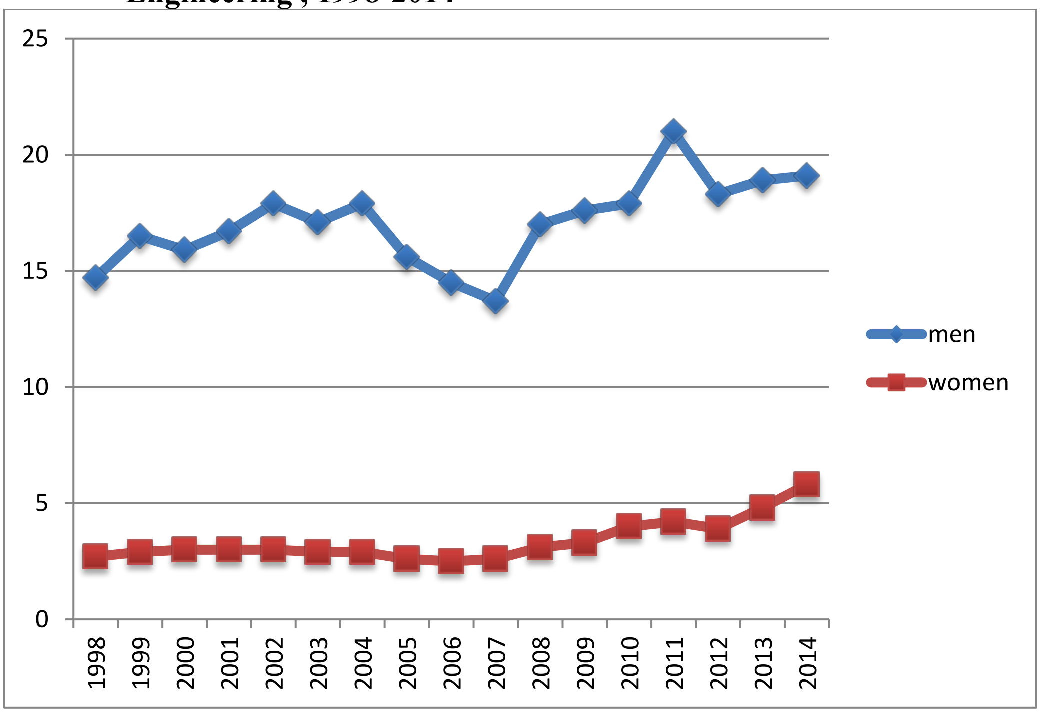
In comparison, in 2011-2012 less than 10% of all United States undergraduate students were in an engineering program: approximately nine percent of men and one percent of women (National Science Foundation, 2017). To create a diverse and qualified workforce, there needs to be an increase in women and underrepresented minority students in engineering (National Science Foundation, 2013).

1.2 Problem Statement

The proportion of STEM Bachelor degrees awarded to women from United States colleges/universities continues to remain low and flat, except in life sciences where women became the slight majority (Eccles, 2011; Good, Rattan, & Dweck, 2012; Goulden, Frasch, & Mason, 2009; National Science Foundation, 2017; National Science Foundation, 2013; National Student Clearinghouse Research Center, 2015; Thoman, Arizaga, Smith, Story, & Soncuya, 2014). In contrast, around the world women earn more than half of the bachelor degrees in the sciences and engineering. In the Middle East, women earned approximately 50% of the science and engineering degrees in almost all of the countries in that region. In Asia, women earned about one-third of science and engineering degrees (National Science Foundation, 2017).

In the United States, in 1998 approximately fifteen percent (15%) of male undergraduate students entered college for engineering. The percentage of men intending to be an engineer increased at a relatively steady rate to 19% in 2014. In comparison, the choice to major in engineering remained significantly lower for women, from a rate of three percent in 1998 to six percent in 2014 (National Science Foundation, 2017). This gender difference is depicted in Figure 1 for undergraduate men and women who entered college for engineering over a 16-year period in the United States. This gender gap in engineering persisted despite more women entered college than men during that time period. (ASHE, 2011; Glazer-Raymo, 2008; National Science Foundation, 2017).

Figure 1. National Data of First Year College Students Intending to Major in Engineering , 1998-2014



Source: National Science Foundation (2017). *Science and engineering indicators 2017: Higher education in science and engineering*

Women in other countries earned engineering degrees at much higher rates than women in the United States. The United States ranked 58 of the 71 countries reported by the National Science Foundation Science and Engineering Indicators (2018) regarding the percentage of women graduating with a degree in engineering. Qatar reported the most equal percentages of men and women (51%) who earned a degree in engineering and the only country where women were the majority. There were high proportions of women who earned a first degree in engineering in other countries: Malaysia (45%); Mongolia (38%); Honduras, Columbia, and Poland (37%); Italy and Romania (35%); and India (32%) (National Science Foundation Science and Education Indicators, 2018).

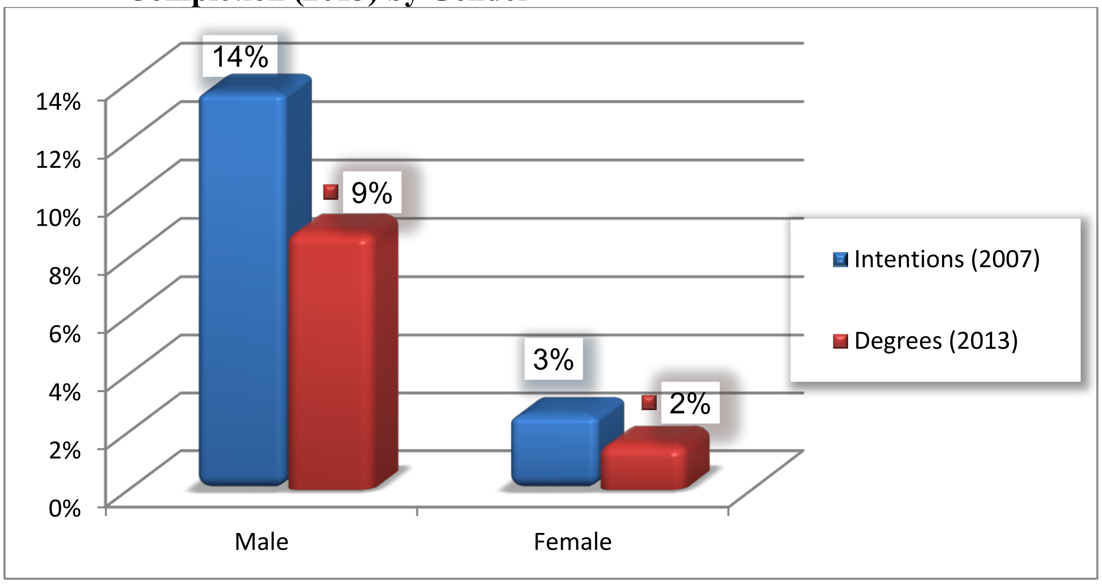
The lower entry into engineering coupled with higher attrition of women from this major have created a persistent gender gap of women in engineering in the United States where women represent only 20% of those earning a degree in engineering (Good, Rattan, & Dweck, 2012; Legewie & DiPrete, 2014; National Science Foundation, 2018; Shapiro & Sax, 2011). There are many research studies investigating why women remained underrepresented in engineering in America. Some studies suggested that girls have limited educational routes if they opted out of the needed prerequisite STEM classes in high school (Eccles, 2011; Watt, Jansen, & Joukes, 2012). And, for those women who took the academic prerequisite classes in high school, they did not necessarily select engineering in college.

Compounding the lack of women in undergraduate engineering was that students change majors while in college. Persistence in any major was not unique to engineering. Students change majors, transfer to other colleges, or stop-out (Thoman et al., 2014). Approximately 80% of college students change their intended majors at least once (Tyson in Borman et al., 2010). For those who change majors out of engineering, they can easily switch to most other majors. But students cannot easily transfer into engineering due to the prerequisite courses. So, a drop out from engineering would not easily be replaced.

Nationally, men and women have left engineering at approximately the same rate: 36% for men and 34% for women (National Science Foundation, 2016). While slightly more women have stayed in engineering, there are fewer women who have entered

(Thoman et al., 2014; Shapiro & Sax, 2011). Figure 2 provides a comparison of intentions of first year students versus degree completion in engineering in 2013.

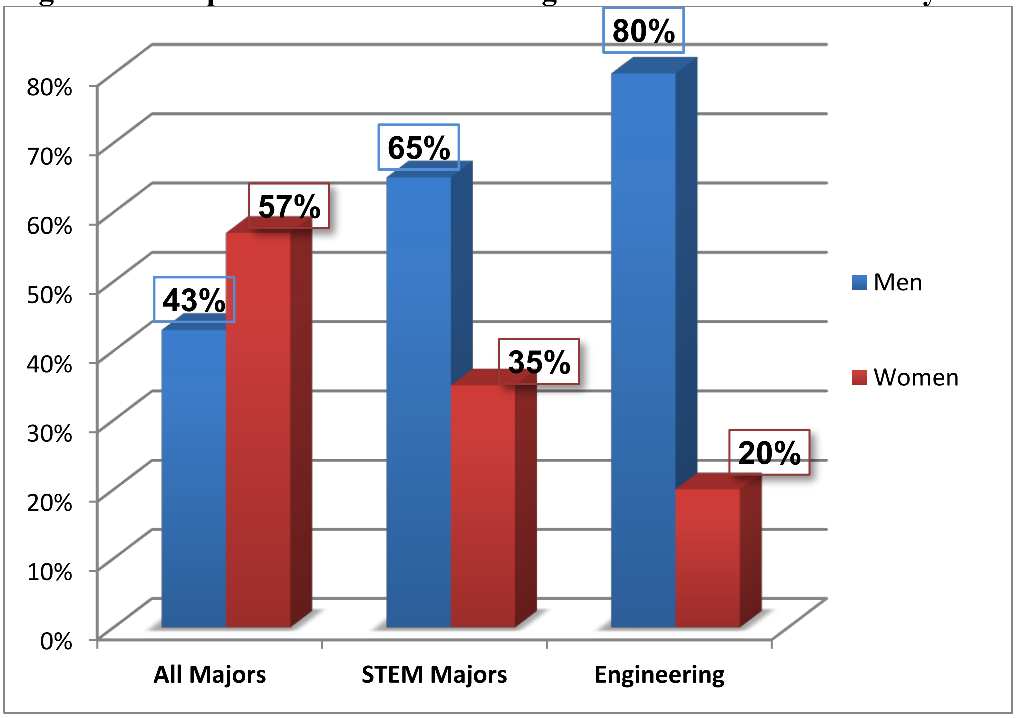
Figure 2. National Data on Intention to Major in Engineering (2007) versus Degree Completion (2013) by Gender



Data source: National Science Foundation (2016). *Science and engineering indicators 2016: Higher education in science and engineering*

The low entry rate and graduation rates for women engineers has remained the same over time. Men earned 80% of the engineering degrees in the United States in the recent past (National Science Foundation: Higher Education in Science and Engineering, 2014; National Student Clearinghouse Research Center, 2015). Figure 3 shows the proportion of Bachelor degrees awarded to all students, those in STEM majors, and specifically engineering majors by gender (National Science Foundation, 2017). The women who graduated as engineers also faced a gender gap in pay, despite efforts to eliminate workplace discrimination (Xu, 2017). This left men predominating at all levels (Hill, Corbett, & St Rose, 2010).

Figure 3. Comparison of Bachelor's Degrees Awarded in the U.S. by Gender in 2014



Source: National Science Foundation (2017). *Science and engineering indicators 2017: Higher education in science and engineering*

The situation was even more dismal for minority women in engineering. Women who did not identify as White enrolled in even smaller numbers in engineering (Litzler, Samuelson, & Lorah, 2014; National Science Foundation, 2017). In 1991, minority women represented only five percent of all those (men or women) earning a baccalaureate degree in engineering and this percentage increased to 10 percent in 2010 (National Science Foundation, 2013). This creates a problem where women lack role models and peers in their engineering program (Litzler, Samuelson, & Lorah, 2014).

1.3 Research Rationale

The United States had fewer students entering engineering as compared with those in other countries (National Science Foundation, 2017). The underrepresentation of women in engineering has persisted despite decades of research on women in college and women in the sciences and engineering fields (Eccles, 2011; Legewie & DiPrete, 2014; Xu, 2017). Prior research, using both quantitative and qualitative methods tried to identify factors that may predict persistence in undergraduate engineering programs (Good, Rattan, & Dweck, 2012).

Many theories have been used to explain persistence in engineering for women. The outcomes of research have been mixed with different factors identified as predictors of success of women in undergraduate engineering. In some studies, Scholastic Aptitude Test (SAT) scores were identified as being correlated with student success in engineering. Students with higher SAT scores, particularly in the math portion of the test, have been more likely to stay in engineering programs than students with lower SAT test scores (Seymour & Hewitt, 1997; Thoman, et al., 2014). Persistence in engineering had also been correlated with higher grade point averages in high school (Brown, Halpin & Halpin, 2015; Guo, Parker, Marsh, & Morin, 2015; Sonnert & Fox, 2012). Often levels of individual self-efficacy have been referenced as related to persistence in engineering for women (Marra, Rodgers, Shen, & Bogue, 2009; Zundl, Stiltz, & Buettner, 2015).

1.4 Purpose of the Study

Given the many factors that push and pull women out of engineering, it was important to identify research-based ways in which more women could be recruited and retained in the major. Research has shown that for students to achieve high academic performance and take more advanced math classes, both math self-concept and the intrinsic value of learning and applying math needed to be high (Eccles, 1983; Guo, Parker, Marsh, &

Morin, 2015). Guo et al. (2015) demonstrated that prior math and science achievement positively predicted math motivational beliefs and the higher probability of intentions to enter college for STEM.

However, while women may enter college in a STEM major, the research substantiated that they did not stay. Therefore, it was important to consider the identified programs and processes in higher education that may be applied to women in undergraduate engineering. Specifically understanding and applying practices in higher education could provide insights into the motivation to enroll in engineering, and the internal and external factors that would affect retention.

1.5 Significance of the Study

With a mission to increase the number of women in STEM fields, the administration at Rutgers University, the Rutgers-New Brunswick School of Engineering (RU-NB SOE), and DRC initiated a women-only living-learning community to address the national issue of too few women in engineering. This community was established with the hopes of positively affecting the recruitment and retention of women in engineering. While themed living-learning communities have existed for some time in higher education including at Rutgers, those for women in STEM are relatively new and a community for only women in engineering had not previously existed at Rutgers. The living-learning community at Rutgers-New Brunswick, named the Reilly-Douglass Engineering Living-Learning Community (Reilly-DELLC), was the first and only living-learning community (LLC) for undergraduate women in engineering at Rutgers University.

Given an underrepresentation of women in STEM majors, particularly in engineering, research that investigated the potential for living-learning communities to affect the recruitment, retention, and achievement of women in engineering could be significant. It was particularly important to assess whether living-learning communities for women in engineering could change the outcome in this field similar to how women's colleges, historically, changed outcomes for women in higher education and opened pathways to many educational opportunities.

1.6 Theoretical Frameworks and Research Questions

This study explored the effects of a living-learning community for the recruitment, retention, and academic achievement of women in an undergraduate engineering school at a public research university. A program evaluation, using a case study, was conducted. Participants were all engineering students admitted between fall semesters 2012 through fall semester 2015. Students were in one of three groups: 1) all men in engineering; 2) women in engineering enrolled in the women-only LLC; and 3) all other women in engineering (excluding those in the LLC). Both quantitative data and qualitative data were collected and analyzed.

The evaluation of the experiences and outcomes of women who participated in Reilly-Douglass Engineering Living-Learning Community as compared with outcomes for all other engineering students was important because prior research has demonstrated that living-learning communities (LLCs) could positively affect retention and degree completion (Brower & Inkelas, 2010). Table 1 summarizes the research questions aligned to theoretical frameworks and the literature.

Table 1. Research Questions Aligned to Theory and Literature

Research Questions	Theoretical Framework			Literature Review		
	Social Capital/ Social Networks/Social Cohesion	Student Involvement (Astin)	Expectancy Value Eccles et. al.)	History of Women's Education	Status of Women in STEM	Living-learning communities
Does a women's-only living-learning community affect the recruitment of women in engineering?	x	x	x	x	x	x
Does participating in a women's-only living-learning community affect the retention of women in engineering at Rutgers?	x	x	x		x	x
How do the undergraduate women in the Douglass Engineering Living-Learning community (Reilly-DELLC) compare academically with men and with undergraduate women in engineering at RU-NB who were not in that Community?	x	x	x		x	x
How do participants in the Reilly-DELLC program experience the Community including its strengths and weaknesses?	x	x	x		x	x

1.7 Contribution to the Literature

This case study focused on experiences of students in the Reilly-Douglass Engineering Living-Learning Community, and how academic and retention outcomes compared with all students in engineering (women and men) who did not participate in the living-learning community. This study may be of interest to Douglass Residential College, Rutgers University, other higher education institutions, and higher education policy makers who seek information on the impact of academic-based living-learning communities.

Given the existing research on benefits of living-learning communities, my research of a women-only living-learning community for undergraduate engineers, within a women's residential college, within a large, co-educational, public research university has a unique contribution to the field. This research contributes to the literature by focusing on the experiences and outcomes for women in engineering who immediately entered a women-only, residential community in their first year in college. The research is significant because there are limited studies that considered gender and major through the lens of social capital theory/social networks, expectancy-value theory, and student involvement theory (Astin, 1984; Guo, et al., 2015; Marra, Rodgers, Shen, & Bogue, 2009).

Chapter 2: Literature review

2.1 Introduction

This review considered varied perspectives for gender differences in starting a college education with plans to major in engineering and persisting in that field. First, an overview of the history of women's access to education and issues for undergraduate women in STEM is provided. Then current issues for women in STEM and specifically for women in engineering, barriers to persistence in engineering, and the role of Living-Learning Communities in undergraduate education are presented.

2.2 The Education of Women

2.2.1 Women's Historical Access to Education

Issues that women face at all levels of higher education today have resulted from historical antagonism toward women's access to higher education (Nidiffer, 2002). Women were completely excluded from learning opportunities until the middle ages from approximately 1,000 A.D. through the 1500's A.D. (Riordan, 1990). One impetus for beginning to educate women was the global expansion of Christianity. The church dictated that religious education was to be done through formal study. So, women were allowed to attend convents and parish schools where reading, writing, and liberal arts were taught to help prepare them to teach religion to children (Riordan, 1990). While women received some formal education through the church, their access to information was limited and they were prohibited from holding positions of power or setting policies (Riordan, 1990).

Educational inequalities continued into the 1500s with grammar schools admitting affluent boys while excluding all children of lower socio-economic status including girls. By the late 1500s, children from families with lower socio-economic status learn the basics of reading, writing, and some arithmetic in grammar schools. Girls were permitted access to this basic education because of their continued role in teaching children (Riordan, 1990).

When elementary-level town schools emerged in the 1800s, education remained primarily for boys. Girls went to school mostly to prepare them for domestic chores and learn the basics of reading, writing, and arithmetic. However, they often had to attend at separate times such as early in the morning, later in the day, or on different days from boys. The disparate education of girls continued until the emergence of Common Schools in the mid-1800s. In the common public-access schools, co-education became the norm because the role of the school was focused on providing basic education and the assimilation of new immigrant children (Riordan, 1990).

While girls had access to early education, they were mostly excluded from attending college preparatory and post-secondary schools (ASHE, 2011). One of the reasons was that women could not hold positions in government or business. Higher education was intended for men, and primarily for those who could afford to enroll in college (Miller-Bernal, 2000).

Prior to 1857, there were only ten colleges/universities in the United States that accepted women: Oberlin College was the first to admit both women and men in 1833. Hillsdale College, through their constitution, banned discrimination on the basis of gender, race, and religion in 1844. Franklin College, with a Baptist affiliation, admitted women into degree programs in 1845. Otterbein College in Ohio opened in 1845 with women faculty and students. Westminster College in Pennsylvania was founded as co-educational in 1851. Willamette University, Lawrence University, and Antioch College each became co-educational in 1853. Elmira College opened in 1855. And, Waynesburg University, in Pennsylvania admitted women in 1857 (Harwarth, Maline, & DeBra, 1997; Miller-Bernal, 2008).

The need to educate women emerged, in part, from the demand for teachers and the increased need for women in the workforce during the time of the Civil War (Harwarth, Maline, & DeBra, 1997). There were originally two types of all-women institutions: 1) seminaries and 2) degree-granting colleges. Seminaries were not degree granting and they were not religious institutions (Riordan, 1990). Rather, seminaries provided serious education in an institution with many regulations (Miller-Bernal, 2000). The seminaries offered an education equivalent to a secondary education with a teacher preparation curriculum. Women attended for teacher education and training in trades like dressmaking and weaving which then enabled them to work (Riordan, 1990).

A more complete college education was provided through degree-granting institutions. In 1859, Swathmore admitted one female student, Helen Magill White. She was the daughter of Edward Hicks Magill who was a faculty member and the college's second president. Helen earned her degree and then admitted to Boston University. In 1877 she became the first woman in the United States to earn a doctorate (Riordan 1990). As there were few colleges or universities open to women, the emergence of women's colleges provided an opportunity for higher education.

2.2.2 The Role of Women's Colleges

Women's institutions have a long and important role in the education of women in the United States (Datnow & Hubbard, 2002; Harwarth, Maline, & DeBra, 1997; Miller-Bernal, 2008; Miller-Bernal, 1993). Degree-granting women's colleges were founded in order to educate women in the way that was already available to men. Women's colleges primarily focused on the study of liberal arts (Harwarth, Maline, & DeBra, 1997; Miller-Bernal, 2008). Some women-only colleges were independent, some affiliated with churches, and others were private and affiliated/coordinated with male-only universities (Datnow & Hubbard, 2002; Harwarth, Maline, & DeBra, 1997). Those that were coordinated/affiliated with men's colleges were called sister schools. These sister schools remained separate, but shared some resources (Datnow & Hubbard, 2002).

The most famous of these schools were the Seven Sisters, all of which were degree granting and formed in the northeast United States in the 1800s (Lewis, 2015). The Seven Sisters included the following schools: Mount Holyoke College, Vassar College, Wellesley College, Smith College, Radcliffe College, Bryn Mawr College, and Barnard College (Lewis, 2015). Mount Holyoke College, originally called Mount Holyoke Female Seminary, was founded by Mary Lyon and opened in 1837 in South Hadley, Massachusetts after she founded Wheaton Seminary, now Wheaton College, in Norton Massachusetts in 1834. Mt. Holyoke was affiliated with Dartmouth College, originally Andover Seminary. Vassar College, located in Poughkeepsie, New York was formed in 1861 as the coordinate school to Yale. Vassar began to admit women in 1865. Wellesley College, located in Wellesley, Massachusetts was founded by Henry Fowle Durant and Pauline Fowle Durant and chartered in 1870. Wellesley began admitting women in 1875 and was traditionally affiliated with both Harvard University and Massachusetts Institute of Technology. Smith College in Northampton, Massachusetts, first admitted women in 1879 and affiliated with Amherst College. Smith College was formed by a bequest from Sophia Smith. Radcliffe College, founded by Arthur Gilman, was affiliated with Harvard University and was first called the Harvard Annex. Radcliffe College, located in Cambridge, Massachusetts, enrolled its first students in 1879. Bryn Mawr, founded by M. Carey Thomas, located in Pennsylvania, in the town of Bryn Mawr, was charted and admitted students in 1885. Bryn Mawr affiliated with Princeton University in New Jersey, the University of Pennsylvania, Swarthmore College, and Haverford College. The final of the original Seven Sisters, Barnard College, located in Manhattan, New York was founded in 1889 as the affiliate to Columbia University (Lewis, 2015).

Since many colleges did not admit women, numerous career paths remained closed to women until the early 1900's (Bix, 2004). Many engineers earned their professional credentials on the job in settings such as machine shops and railroad yards, which were work places that excluded women (Bix, 2004). Women who did study engineering in college were seen as outsiders and terms such as *invading* were used to describe the few women who were enrolled in engineering classes (Bix, 2004).

2.3 Colleges Go Coeducational

After the Civil War a decline in male students, some other colleges began to admit women (Harwarth, Maline, & DeBra, 1997). Between 1870 and 1930, the majority of colleges and universities went from being men-only to being coeducational institutions.

Table 2 illustrates the number of institutions from 1870 through 2015 with the percentages that were single gender and co-educational.

Table 2. U.S. Higher Education Institutions 1870-2015

Year	Number of Institutions	% Men Only	% Women only	% Coeducational
1870	582	59%	12%	29%
1890	1082	37	20	43
1910	1083	27	15	58
1930	1322	15	16	69
1960	2028	12	13	75
1970	2573	6	8	86
1980	3253	3	4	93
2010	4599	< 0.007% (3 colleges)	< 0.01% (60 colleges)	99
2015	4706	<0.007% (3 colleges)	0.01% (43 colleges)	99%

Sources: Riordan, C. (1990). *Girls and boys in school: Together or separate?* New York and London: Teachers College Press; National Center for Education Statistics (2013). *Digest of education statistics* (NCES 2014-015), Table 317.10, 2013; Women's College Coalition, 2015)

As new public and private colleges proliferated throughout the United States, fewer single-gender colleges opened or remained (Goldin & Katz, 201; Riordan, 1994). In the west and mid-west regions, coeducation was the norm with women's colleges representing simply an additional option for women (Langdon, 2001). Higher education options continued through the early 1900's as a result of more options of women's colleges and colleges becoming co-educational.

Women's representation in college continued to increase and by 1910 women represented 35% of all college students. Women were also being admitted to graduate and professional schools. In the 1920s the number of women in college grew to 47%. However, due to political and societal issues including the World Wars, women needed to work while men served in the military so women could not attend school. Between

1930 and 1950, college attendance for women dropped to only 30% (ASHE, 2011). By 1955 women began to return to college representing 38% of the students. College attendance continued to grow and in 1965, there were 1,441,822 first time students seeking a degree with the majority (58%) comprised of men (U.S. Department of Education, National Center for Education Statistics, 2013). While men were the majority in college, total numbers of women entering college more than doubled between 1955 and 1965. But, the Ivy League colleges remained for men only.

2.3.1 Colonial Colleges Follow Suit

Ivy league colleges, such as Princeton, Yale, Dartmouth, and Harvard that historically only admitted men began the transition to become co-educational in 1969 (Malkiel, 2017). The first of the elite colleges to become coeducation was Harvard University. The impetus for coeducation in college was driven by the social movements of the 1960s such as civil rights, student rights, women's equality, and opposition to the Vietnam War. Policy changes in society helped to create opportunities that opened college doors to women (Malkiel, 2017). The adoption of co-educational admission by single-gender colleges spread quickly.

When prestigious men's colleges transitioned to coeducation, prestigious women's colleges followed their lead (Clarke, 2011). Similar to men's colleges, the admission of men into women's colleges started in the late 1960s to the early 1970s (Simson, 1971). Vassar, recognized as the first women's college in the country, was also the first to accept men. Many institutions became coeducational for financial reasons, as women began to seek co-educational colleges in larger numbers (Clarke, 2001; Langdon, 2001). As more men and women chose coeducational colleges, the pool of applicants for single-gender colleges began to shrink from 1970 through today (Riordan, 1994). Almost half of the women's colleges existing in 1960 were merged, closed, or turned into coeducational institutions before the 1980s because of fiscal constraints (Miller-Bernal (2000); Langdon, 2001). In 1965, 42% of all college students were women. By the mid-1970s, the number of women attending college doubled, but men continued to predominate. A sustainable alternative for women's colleges was to partner with coeducational or men's colleges, thereby sharing students and resources (Idema, 2010).

2.4 Equal Opportunity in Public Education

Women gained legal access to education in 1972 with the passage of Title IX of the Education Amendments (later renamed the Patsy T. Mink Equal Opportunity in Education Act, 2002). Title IX provided that no one could be excluded from or denied the benefits of education or be discriminated against under any education program that received Federal financial aid (Section 1681(a), ASHE, 2011). This legislation enabled more women to enter college and by 1985 women enrolled in all levels of college at higher rates than men (ASHE, 2011; Good, Rattan, & Dweck, 2012; National Center for Education Statistics, 2012). In 2010, women earned 63% of Master's degrees and 53% of doctoral degrees (National Center for Education Statistics, 2013). In 2013, a total of almost 17.5 million students attended a college and 57% of them were women (ASHE, 2011; National Center for Education Statistics, 2013; Snyder & Willow, 2014). Table 3 contains information on first time college enrollment by gender.

Table 3. Enrollment of First Time Students in Higher Education (U.S.) by Gender

Year	Total	Women ♀	Men
1955	670,013	254,409 (38%)	415,604 (62%)
1965	1,441,822	612,609 (42%)	829,215 (58%)
1975	2,515,155	1,187,220 (47%)	1,327,935 (53%)
1985	**2,292,222**	**1,216,486 (53%)**	**1,075,736 (47%)**
1995	2,168,831	1,167,779 (54%)	1,001,052 (46%)
2005	2,657,338	1,457,283 (55%)	1,200,055 (45%)
2012	2,990,280	1,605,184 (54%)	1,385,096 (46%)
2015	*3,331,000*	*1,812,000 (55%)*	*1,518,000 (45%)*

U.S. Department of Education, National Center for Education, Integrated Postsecondary Education Data. (2013).

2.5 Access Does Not Equal Representation

While more women enrolled in college since 1985, they have not pursued the same majors at the same rates as men. Overall, men chose STEM at much higher rates than women and the gender gap for women in STEM widened at each step in the pipeline (Hill, Corbett, & St. Rose, 2010; Settles, Cortina, Buchanan, & Miner, 2013). Specifically, within STEM the underrepresentation of women in engineering, computer science, and the physical sciences remained significant. For the past 40 years up to 20% of men in college have pursued engineering degrees. In comparison, the choice of an engineering major remained significantly lower for women. Nationwide, the total numbers of women entering college for engineering has remained at or below 4% (ASHE, 2011; Glazer-Raymo, 2008).

2.6 Why Choose Engineering

College and career choices are affected by decisions and opportunities that happen throughout a person's life (Morgan, Dafna, & Weeden, 2013). The life course perspective was an important theoretical orientation because it considered the factors affecting entry into the engineering major. In combination with other theoretical perspectives, the reasons that led a student into a major and the factors that resulted in persistence were considered in the review of the literature and the study.

Research by Morgan, Gelbgiser, and Weeden (2013) has shown that high school can be particularly important in affecting college choices because there were critical decision points that impact college preparation and career choices. Much of the gender gap in college majors was the result of gender-specific career choices and courses taken in high school (Legewie & DiPrete, 2014; Morgan, Dafna, & Weeden, 2013). This differential enrollment in majors has created a persistent gender gap in certain professions.

Related research suggests that early encouragement can also be a critical factor for women entering the STEM pipeline (Tai, Liu, Maltese, & Fan, 2006). There is considerable evidence that women have selected engineering because of factors including: 1) the encouragement of family members, close family friends, or influential teachers who supported their decision, 2) performance in high school math and science, and, 3) expectations about the profession (Bottia, Stearns, Mickelson, Moller, & Parker, 2015; Wang, 2013). More young women than men attributed their initial choice of STEM to the active encouragement of someone important to them (Seymour, 1995).

However, initial encouragement was not enough to keep women in engineering. Research has shown that while women entered the major because of initial, personal encouragement from a family member, teacher, or friend, there was a disproportionate number or women who left the field largely due to negative experiences with male peer students and professors while in college (Seymour, 1995). Why they leave was important to understand regarding higher retention rates for women in STEM.

2.7 Why They Leave Engineering

Engineering continues to experience retention issues for all students. Despite initial intentions to major in engineering, both male and female students switch out of or feel pushed out of engineering (Thoman et al., 2014). Because fewer women enter engineering, there are fewer women who graduate from engineering. Nationally, fewer than 25% of all students graduating with a degree in engineering have been women (National Science Foundation: Higher Education in Science and Engineering, 2014; National Student Clearinghouse Research Center, 2015).

There have been many reported reasons for students leaving engineering. Some students don’t feel prepared. They may have thought that engineering was right for them because they were good at math or because of anticipated attractive starting salaries. Some students just attempted to make it through the pre-requisite courses, hoping that once the basic courses were completed, they would get to the “good courses”; but the curriculum got increasingly harder (Tyson in Borman et al., 2010).

Research showed that for high school students entering college, there was a link between a students’ perception of their math ability and their motivation to enroll in math courses (Eccles, 2011; Guo, 2015). Guo (2015) found that on average, high school girls were less likely than boys to enroll in advanced-level math courses as a result of lower math self-concept, lower intrinsic math motivation, and having placed less value on math than boys. This was consistent with other research that showed girls opt out of the STEM pipeline by not taking the necessary pre-requisite courses in high school, which limited their college options (Watt, Jansen, & Joukes, 2013).

Even when students have taken the prerequisite math and science courses, they may not feel prepared for engineering coursework in college. Research has shown that some students don't know what to expect in an engineering program. They begin to feel underprepared for the required engineering coursework, which leads to less motivation to continue and feeling that they just don't "fit" (Good, Rattan, & Dweck, 2012; Thoman et al., 2014; Tyson in Borman et al., 2010).

A student's perception of fit can be a factor that affects all levels of an undergraduate education, from admission through to graduation (Tyson in Borman et al., 2010). Fit may include a sense of belonging to a group and how that might relate to expectations of and interactions with the environment (Good, Rattan, & Dweck, 2012; Thoman et al., 2014; Tyson in Borman et al., 2010). For example, the process of searching for a college, and visiting or touring the campus, can help to how one fits (belongs) in that college. The experiences that students have on campus become part of the consideration, including the size of the college, the majors offered, whether the college was public or private, location, the number of students in a class, the opportunities to connect with faculty, urban versus suburban campuses, and financial aid packages (Good et al., 2012; Thoman et al., 2014).

Students do continuously re-evaluate their own perception of fit and belonging. A student's background, social circles, support from faculty and peers, as well as their academic performance can also impact their perceptions of belonging both before they enroll and when they begin their studies (Thoman et al., 2014). Fit is the feeling of being accepted as a member of the academic community where students feel that their contributions were valued. This includes being taken seriously as a professional (Cech, 2015). Also, the ways in which students experience the campus culture will affect whether or not they feel that they belong. The more students perceive their knowledge and values fit, the more likely they will persist (Cech, 2015).

Undergraduate engineering can be challenging with prerequisites needed to enter the major and sequential courses that become requirements towards degree completion. Due to the complexity of the concepts in engineering, the courses become more demanding as the student progresses. The *culture of engineering* prioritizes academic study over social life, which can feel isolating to students. This culture is true for STEM majors, in general, but the engineering curriculum is considered particularly difficult and isolating. When students feel being on the fringe of a group, isolated from peers, or not valued by their peers, then feelings of social isolation can become a factor that may negatively affect their persistence in the major or in college (Good, Rattan, & Dweck, 2012; Tyson in Borman et al., 2010).

Social isolation can occur for students who are not successful in building peer relationships and those who feel the pressures of college without support. Perceived failure is another factor that affects persistence. Many students who enter engineering were high academic achievers in high school and may not be able to accept a low grade in their college courses. This can lead to perceived failure in the major. Similarly, students who have to take and/or retake difficult courses may feel overwhelmed or discouraged by having to continue to take increasingly more difficult courses for a sustained period of time. Without social and academic support, engineering students may question their own abilities to succeed and look to other majors (Good, Rattan, & Dweck, 2012; Tyson in Borman et al., 2010).

Eccles (2011) suggested that the value a person assigns to certain educational and career choices are influenced by the behaviors and attitudes of other people, including those they interact with on a daily basis. Ones own perceptions of academic and social fit conform to other people's perceptions. There are actual and perceived expectations on the part of faculty, peers, and the students themselves.

Eccles (2011, 1983) proposed students' self-concept is formed in two parts: 1) as a function of comparing their own performance to that of their peers (external comparison), and 2) their perception of their own performance (internal comparison). Parents, teachers, and peers influence self-concept. People who are considered influential in a student's life can affect what the student perceives as options via the information and experiences that influencers provide – including giving or withholding support, encouraging or discouraging options, etc. (Eccles, 2011; Guo et al., 2015).

Externally imposed labels could also affect self-concept. A person may begin to think that what others say about him/her may be true and internalize the labels (Steele & Aronson, 1995). The Stereotype Threat theory posits that people who are members of a stigmatized group will tend to perform worse on stereotype-relevant tasks when presented with the negative stereotype (Flore & Wicherts, 2015; Steele, 1992). If the threat persists over time, anxiety about being judged can create the possibility of suppressing interest in, achievement of, and persistence with academics (Steele, 1992).

Negative stereotypes carry a strong message that can affect a sense of belonging in certain groups. This is relevant to women in STEM because actual achievement can be compromised by the perceived stereotype that devalues achievements (Steele & Aronson, 1995). This has been observed in women underperforming when gender was made relevant to performance in a task. For example, research has shown that girls underperformed on math tests when their gender was made relevant -specifically their ability to achieve versus their interest in math (Ambady, Shih, Kim, & Pittinsky, 2001; Galdi, Cadinu, Tomasetto, 2014; Neuville & Croizet, 2007; Tomasetto, Alparone, & Cadinu, 2011). It has been demonstrated that girls as young as six-years old automatically associate the stereotype that boys are better in math and girls are better in language if the girls were made aware of this stereotype prior to performing math work. The research has also demonstrated that when this stereotype was activated prior to the task, the performance of the girls was lower on math tests. Conversely, when the stereotype was inconsistent (statements made ahead of time that girls do better in math), then the result was girls achieved the highest scores (Galdi, Cadinu, & Tomasetto, 2014).

Research has shown that the classroom environment is also gendered where women experience bias, discrimination, and a chilly climate (Allen & Madden, 2006). The term chilly climate was first reported in, The Classroom Climate: A Chilly One for Women? (Hall & Sandler, 1982). This term was used to describe the environment in which women were treated differently from men, both inside and outside of the classroom.

The chilly climate is an overall institutional atmosphere that discourages or stifles women students' personal, academic, and professional growth (Hall & Sandler, 1982). This differential treatment had a negative impact on the performance of women in college (Morris, 2003). Examples of a chilly climate included: discouraging women from participating in class discussions, encouraging women to drop classes or pursue other majors, implying that women lack commitment to certain majors, making disparaging comments about women, being negative about women's professional accomplishments, and/or demeaning women in overt and covert ways. Demeaning comments and actions included, referring to women as girls, making sexist comments, ridiculing research about women's feelings and perceptions, or making direct sexual advances towards women in the classroom (Hall & Sandler, 1982; Morris, 2003).

Seymour (1994) suggested that limited relationships with science faculty and the impersonal nature of science, math, and engineering activities also contributed to a chilly climate in STEM classrooms. Some professors also created and perpetuated an elitist environment with regards to engineering curriculum and student success. Some faculty, administrators, and students who persisted in an engineering program can create a culture where they took pride in the rigors of the program and blamed those who quit for not being prepared (Tyson in Borman et al., 2010).

These are some of the many factors that can cause women to leave engineering. In addition to factors that push students out of engineering, there are the pull factors that bring students into new, non-engineering majors (Thoman et al., 2014; Tyson in Borman et al., 2010). Switching majors may enable a student to avoid upper level math classes and eliminate other difficult courses. In general, when engineering students switch majors, they rarely lose credit because the courses they took count as core or elective courses in another major, particularly for the social sciences or business programs. This often enables completion of an undergraduate degree in four years, even after changing majors because credits are not lost. Students who switched from an engineering major also reported feeling less stressed than their counterparts who stayed in engineering (Tyson in Borman et al., 2010).

There are fewer women working or teaching in engineering and, therefore, fewer role models exist in higher levels of administration, faculty, and the workforce (Heppner et al. in Borman et al., 2010). In 2011, there were 1,569,000 people employed in the engineering profession as practicing engineers or postsecondary teachers (1,369,000 were men and only 200,000 were women.); engineers who taught totaled 43,000 (38,000 men and 5,000 women). Women represented only 12% of faculty in engineering or were employed as engineers. The numbers of women engineers who were full-time professors were even lower at only five percent of all engineering faculty, nationwide (Richman & vanEllen, 2011). Therefore, women students don't have many same-gender models in the workforce or in education as engineers or leaders (National Science Foundation, 2013). With low numbers of women who graduated with degrees in engineering, the pipeline does not expand for women (National Student Clearinghouse Research Center, 2015).

Chapter 3: Theoretical Frameworks

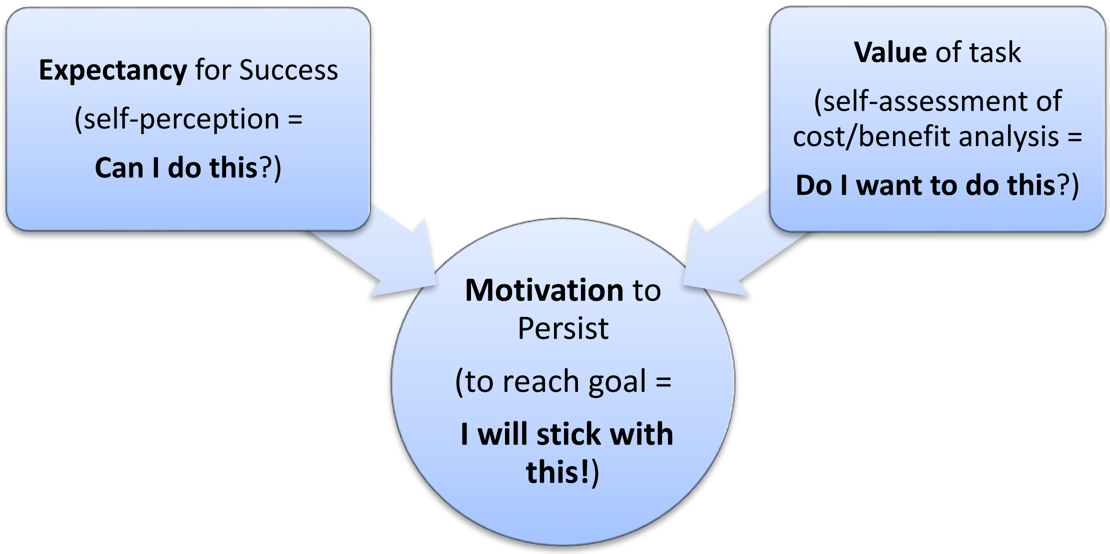
3.1 Introduction

Several theoretical frameworks informed this research and linked student engagement in a living-learning community (LLC) to student success. The theories included social capital theory/social networks, Eccles et al. (1983) modern expectancy-value motivation theory (EVT), life course perspective, and Astin's (1984) theory of student involvement. I discuss the application of these theories in my review.

3.2 Motivation Theory: Expectancy-Value

Modern Expectancy-Value Theory (EVT) was one of the major frameworks of achievement motivation that considered students' self-concept and expectancies, which could ultimately influence persistence in a major (Eccles, 2013; Eccles, 2011). *Expectancies* are beliefs in the capacity to succeed in college and *value* is the self-evaluation of the potential costs and the benefits associated with a chosen path (Eccles, 2011; Guo et al., 2015). Figure 4 is a simplified visual representation of Expectancy-Value Motivation Theory (Matusovich, Streveler, & Miller, 2010b, Eccles et al., 1983).

Figure 4. Overview of Expectancy-Value Motivation Theory



Expectancy-value theory also considered gender differences in STEM persistence (Morgan, Gelbgiser, & Weeden, 2013). For example, women may have developed lower levels of confidence in STEM preparatory courses and, through subjective valuation, began to think of STEM-related courses and careers in STEM to be less desirable than other courses and other careers (Gaspard, Dicke, Flunger, Schreier, Haffner, Trautwein, & Nagengasi, 2014; Morgan et al., 2013). This theory frames educational and career choices by considering that people continuously make choices about how they will spend their time and energy.

Choices (both conscious and unconscious) are conditioned by feedback from others and cultural norms that influence self-concept and perceived options. The subjective value of a task is defined by Eccles (2011, 1983) as: 1) the perceived usefulness of the task in attaining desired external rewards, 2) intrinsic interest in and enjoyment of engaging in the task, 3) the value the activity has in helping the person express his/her own core values, personal identity, and/or social needs, and 4) the cost of engaging in the activity. The relative value and the chances of perceived success can also be influenced by feelings of self-competency, perceptions of the difficulty of the task, and personal goals (Markus & Wurf, 1987). Perceptions of other peoples' attitudes and other peoples' expectations can also impact self-concept and, in turn, affect choices (Morgan, Gelbgiser & Weeden, 2013; Musu-Gillette, Wigfield, Harring, & Eccles, 2015).

Choices are assumed to be associated with costs, as one choice often eliminated other options (Eccles, 2011). Cost may not necessarily be monetary but could be influenced by factors such as fear of failure, anticipated anxiety of engaging in the task, or the perception of the social consequences of success in the task (Eccles, 2011). Cost could also be the loss of time and energy for other things. All of these factors affect the perceived value of pursuing certain academic and/or career options and the fit of those options.

3.3 Efficacy and Collective Identity

Self-efficacy is the degree of confidence people have in their abilities. Self-efficacy beliefs determine behaviors, motivation, and how people think and feel (Bandura, 1994). People who believe that they have the capability to succeed (high self-efficacy) will approach difficult situations with a more positive outlook rather than avoidance. Those with strong efficacy maintain commitment to achieving goals and persist even in the face of failure with a firmer commitment to achievement. When there are setbacks, those with high self-efficacy recover more quickly because of the belief that with more information or more effort success is possible. In general, those with high self-efficacy maintain an attitude that situations can be controlled and changed. This perspective often does produce positive results, reduces stress, and lowers vulnerability to depression (Bandura, 1994).

In contrast, people who doubt their own abilities or shy away from difficult situations typically have lower aspirations and weaker commitment to the goals. When faced with adversity, they question their own skills and abilities. With the self-belief that success might not be likely, people with low efficacy give up more quickly and are slower in recovering their sense of value when faced with failure. By viewing their own performance as a contributing factor to setbacks, they more quickly lose faith in their capabilities. People with low self-efficacy more easily become stressed and suffer from depression and isolation (Bandura, 1994).

There is a connection between social support and self-efficacy related to psychological health and promoting healthy behaviors (Berkman, et al., 2000, Epstein, 2003; Nieminen, et al., 2013). Social support affects feelings of self-esteem and self-worth, helps people through stressful situations, affects mental health, and assists with coping. Self-efficacy, coping styles, and self-esteem may affect the type of support people ask for and how they ultimately use that support. People who believe they can control their environment can more successfully handle stress and are more likely to seek support when needed (Berkman, et al., 2000; Carpiano & Hystad, 2000; Cattell, 2001). Those people who believe they have little or no control, may feel isolated and perceive their environment to be more threatening (Bandura, 1994). People who feel or are socially isolated are at increased risk for depression (Berkman, et al., 2000; Cattell, 2001).

Self-efficacy is important in maintaining on-going participation in social networks. By the choices people make, they develop different interests and social networks that determine life courses. The social influences in those networks affect the actions, values, and interests of the individuals and the collective group (Bandura, 1994). Individual self-efficacy beliefs contribute to collective self-efficacy in important ways. Collective efficacy is an important mediating variable in social networks (Ford, Sacra, & Yohros, 2017). Collective efficacy is defined as the ability of a community to control the behavior of its residents (Sampson, 1997). Self-efficacy and social support may be reciprocal (or confounding) so that social support may raise self-efficacy or people with higher levels of self-efficacy may be more socially involved (Berkman, et al., 2000; Cattell, 2001). Social networks promote self-efficacy, which affects outcomes.

Self-efficacy contributes to the creation of bonding social capital as people work towards collective action. Communities or groups with strong bonding social capital are more likely to have high levels of trust and communication within their community. Trust provides a foundation in which people can discuss important issues (Aveling & Jovchelovitch, 2014). Communication and co-operation facilitate the sharing of resources and communication is key in enabling different voices to be heard.

When people feel empowered to think and take action on conditions that affect their lives, they gain an awareness that can push a community forward. Community action then reinforces links in and between communities (Campbell & Jovchelovitch, 2000). High levels of bonding social capital gives people a sense of control over their lives because of the ability to participate and shape group discussions and decisions. When people have control over other aspects of their lives, they are more likely to take control of their lives (Gibbs, Campbell, Akintola, & Colvin, 2015). Self-efficacy and collective efficacy are important for living-learning communities for the contributions towards building trust, fostering cohesion in the community, and enabling the community to advance.

3.4 Social Capital Theory

Social capital theory broadly considers the social networks, social cohesion, interpersonal trusts, and reciprocal relationships between people and how this directly relates to benefits and outcomes (Carpiano & Fitterer, 2014; Coleman, 1988; Ertel, Glymour, & Berkman, 2009; Moore, Bockenholt, Daniel, Frohlich, Kestens, & Richard, 2011; Putnam, 2003). Generally, social capital can be considered via two main approaches: cohesion and network methodologies. Cohesion approaches consider social capital in terms of trust in others, perceptions of social belonging and integration, and levels of civic or social participation. Network approaches measure social resources and consider social networks, in relation to inequalities in access to those social resources. In either approach, social capital is seen on the interpersonal-, structural-, and policy-levels each one having individual-level outcomes (Moore & Kawachi, 2017).

In the literature, several definitions or components of social capital have been proposed. While social capital has been researched in many different fields of study and defined by many researchers, the theories of Pierre Bourdieu, Robert Putnam, and James Coleman have been fundamentally influential in understanding social capital, social networks, social cohesion, social needs, and in researching and hypothesizing the relationships of social capital with behaviors and outcomes from a sociological perspective. All definitions directly or indirectly refer to the social resources (the capital) that exist in relationships between individuals and groups where resources become available to members of a given group (the social network) (Bourdieu, 1989, 1991; Coleman 1988, 1994; Putnam 1993, 2000, 2003). Social capital theories broadly consider the social networks, social cohesion, interpersonal trusts, and reciprocal relationships between people and how these directly relate to access to resources and/or information (Carpiano & Fitterer, 2014; Coleman, 1988; Ertel, et al., 2009; Moore, et al., 2011; Putnam, 2003). In addition, these theories focus on how social ties among individuals, enhance trust and reciprocity, affect community participation, and consequently, impact individual outcomes.

Social capital has been defined as resources on both the individual and structural levels (Maass, et al., 2016). Structural social capital is generally considered to be what people do or access (can be observed or verified) through networks or social links. Structural social capital enables social interaction through formal and informal networks. Whether social capital is derived from the structural factors such as the national resources (e.g. access to education), or by relationships on the individual level (intimate friendships or family support), there is an impact (Chang et al., 2017; Nguyen & Rieger, 2017; Poortinga, 2006; Weiss-Faratci et al., 2016; Younsi & Chakroun 2016).

Social capital involves resources available to members of social groups (networks) and that the networks are tied to trust, norms of behavior, and sanctions. The social group can be formed at a work place, a voluntary organization, religious organization, community group, or a residential community. The core of this definition is that social capital is conceptualized as a group attribute. Another definition views social capital as resources embedded within groups. The resources become a benefit of belonging to the group such as the development of social cohesion, social support, information channels, and social connections within and between groups (Villalonga-Olives & Kawachi, 2015). Social cohesion is a component that considers the effects of community-level social capital as a group attribute. Community-level social capital is important because people spend many hours in their communities (Saito, Kondo, Aida, Kawachi, Koyama, Ojima, & Kondo, 2017).

The importance of a multi-dimensional approach to the understanding of social capital has emerged with continued research (Carpiano, 2007, 2008; Carpiano & Fitterer, 2014; Carpiano & Hystad; 2011; Moore et al., 2011). Researchers have used social capital theory to help explain a wide variety of social, economic, and health matters. Social capital theory has also been recognized as a means to promote wellbeing because social capital creates bridges to resources, information, and people. Individuals or groups use these resources to reach individual or group goals (Bourdieu, 1991). The use of these resources helps people achieve better social, economic, educational, and/or health outcomes.

The fundamental theories of capital include bonding capital, bridging capital, and linking capital. The development of capital is important for people who are underrepresented because of the need to connect to resources. The connection to other networks facilitates access to assets and information that may not be available in the original network (Fung & Hung, 2014; Granovetter, 1983).

3.4.1 Bonding, Bridging, and Linking Social Capital

Bonding social capital is considered more of the inward looking perspective of social networks, which reinforces group identity. Bonding social capital considers trust and cooperative relationships within a network where people share social identities. It can be considered a horizontal link (within networks) (Poortinga, 2012). Bonding social capital is created *within* (not between) communities. Social capital is created when people share with each other, reciprocate, and offer assistance to each other in a community.

Bridging social capital can be considered more of the outward looking perspective of social networks that crosses between different social groups. Bridging social capital links people and resources between networks and is therefore a vertical link (Small, 2009; Fung & Hung, 2014). One reason that bridging social capital can be valuable is that the sharing and reciprocity which occurs in groups that function with high bonding social capital (tight-knit communities) are limited by the resources available within that network. For example, when a crisis affects a community, there is a limit to the support the network members can provide to each other. In those instances, communities that are collaborative and supportive (high bonding social capital) may be further disadvantaged because already strained resources will be further stressed. This creates a situation where resources are depleted and there is little that can be share with others in the community (Villalonga-Olives & Kawachi, 2015). Bridging social capital, by contrast, refers to the connections that explicitly cut across economic and status differences (Fung & Hung, 2014; Granovetter, 1973; Putnam, 1983).

Communities that have high bridging social capital may be able to access a wide range of resources and achieve influence through the diversity of people that are part of that community (Kim, Subramanian, & Kawachi, 2006; Villalonga-Olives & Kawachi, 2015). Because the foundation of bridging social capital is the sharing of information and resources across networks, valuable knowledge can be more widely distributed. Next, if actual work (people doing things to help one another) and emotional and social support can be improved, research has shown that there are widely reported connections to improved outcomes (Moore & Kawachi, 2017; Younsi & Chakroun, 2016). Information that is shared between networks helps to promote stronger connections across disparate social groups within the larger community (Villalonga-Olives & Kawachi, 2015).

Linking social capital emerged as an extension of the theory of bonding and bridging social capital. Linking social capital is the development of trusting relationships across networks with differing powers or authority (Poortinga, 2012; Szreter & Woolcock, 2004). It is suggested that all three forms are important: bonding social capital for the fundamental social cohesion and support, bridging social capital for helpful connections to others in society, and linking social capital for the ability to access and use political resources and power (Poortinga, 2012).

3.4.2 Bourdieu's Theory of Social Capital

Pierre Bourdieu (1989, 1991) defined social capital as the resources that become available for use or exchange based on social connections, mutual acquaintance, and/or social recognition. Bourdieu focused his research on understanding social hierarchy, the reproduction of inequality in society, and how people achieve success given the differential distribution of wealth and resources (capital). He theorized social capital along with three other forms of capital: economic, cultural, and symbolic. Social capital according to Bourdieu (1989) is collections of resources that accumulates and are exchanged through associations in a stable network of mutually established relationships. The resources (actual or potential) within the networks can be material, information available to group members, psychological support, and/or social relationships (Carpiano & Fitterer, 2014; Sadovnik, 2007).

Bourdieu's theory of capital encompasses economic, social, and cultural wealth in relation to a person's position in society and his/her ability to access, use, and exchange resources within and between networks (Sadovnik, 2007; Veenstra & Patterson, 2014). In Bourdieu's model, economic capital is at the core of social and cultural capital so that with economic resources you can gain access to other forms of capital and be more easily able to draw on the resources of the network and convert or exchange capital within those spaces. Bourdieu (1991) views social capital in the context of the position that a person has in given social spaces. The ability to activate the resources that are inherent in relationships with friends, acquaintances, school, and/or business contacts enables people to transfer social capital into a commodity that can lead to achieving personal and social goals (Bourdieu 1991).

Cultural, economic, and social capital can have clear and measurable effects on people's lives (Veenstra & Patterson, 2012). Individual ties to a group allows for the utilization of resources that are embedded in each social network and different groups have varied access to resources. Bourdieu defines this as habitus. Habitus encompasses both class and individual attributes. A person's habitus is created through class structure and position in society. This leads to situations in which groups of people can have shared behaviors and values in a given environment. These shared values are then produced and reproduced within the group. Habitus can help explain how health issues emerge and how social relations, through power, lead to inequalities (Frohlich et al., 2001).

In Bourdieu's (1989, 1991) theory of inequality, which he sees being reproduced through the educational system, he implicitly acknowledges that there is an unequal distribution of social capital. He suggested that this inequality is based in a disproportionate availability and distribution of the resources needed to obtain the social capital. Therefore, the value of the social capital differs depending on to whom it is available and who is accessing it. If, for example, someone enrolled in an elite private university is in a high socio-economic status with a high social status then that person may have a lot of resources readily available. In contrast, someone who lives from paycheck to pay check, never attended college, and is considered in a lower socio-economic status may have fewer resources available. Lower socio-economic status and less education could more likely result in diminished social capital. While a person could have many social ties, and some social capital, it may be qualitatively different from another person whose social resources may be considered to have more value based on general societal standards. Based on Bourdieu's inequality model, these conditions affect the quality of a person's social capital, that, in turn, affects positions in the social hierarchy (Bourdieu 1989).

Bourdieu's theory delineates how social capital can be created and becomes available within networks but does not address how capital is used or distributed in the network. There is considerable debate as to the role of an individual being the agent to construct his/her habitus, rather than the habitus (structure) defining the person (Veenstra

& Burnett, 2014; Frohlich et al., 2001). This leaves theoretical consideration of lifestyle choices and variations between groups as a basis for stratification, in addition to structural and class differences.

3.4.3 Putnam and Mutual Reciprocity

Robert Putnam (1993) defined social capital as the trust, norms, and mutual reciprocity in networks that generate links to resources. Trust is a fundamental component of social capital in Putnam's theory, because of its connection to the norm of reciprocity as well as the broad and localized benefits that are derived from trust (Putnam, 1993). Putnam (2000) further delineated *thin* from *thick* trust. Trust between acquaintances or a stranger is considered thin trust. Putnam theorized that thin trust is important in creating community social capital because of the outreach between individuals and a willingness to help others that is foundational in forming and maintaining relationships. *Thick* trust is built based on strong ties such as those typically developed in families and with close friends.

For Putnam, the trust that underlies mutual reciprocity is essential in building and maintaining social capital. He theorized two forms of social capital: Bonding or localized and bridging social capital. Localized social capital (bonding) is created through informal social interactions that happen in social groups in which people participate on a regular basis (Putnam, 1993, 2000). This includes family relationships, and social interactions that occur in religious organizations, civic organizations, and/or any social group that people engage with on a steady basis. Trust is generally thicker in bonding capital.

Putnam's Bridging capital (thin trust) is based on the research of Granovetter (1974, 1983) as the links to other networks. Bridging capital is important because relationships with people outside of an immediate or local network facilitate the sharing of new information or opportunities. Granovetter (1974, 1983) refers to these as *weak ties.* Putnam (2000) suggests that thin trust or weak ties are the foundation of bridging capital. Research has shown that without bridging capital, networks do not automatically connect to resources outside the network, even with efforts to strengthen the localized network (Granovetter 1974, 1983). For example, simply strengthening ties within an urban neighborhood (building localized social capital) does not necessarily produce improved resources within that community, unless there are links that create connections to groups outside the neighborhood.

A focus of Putnam's theory was civic engagement based on his early work on the economic development of Italy. His research suggested differing levels of political and economic success in neighborhoods in Italy that were attributable to social relationships based on volunteerism, community involvement, and civic engagement (Putnam, 1993, 2000). Putnam suggested that regions in which local governments performed well also had higher levels of civic engagement as measured by voter turnout, newspaper readership, and participation in community groups. Putnam theorized that people who were more willing to get involved were able to build more social capital. Higher levels of civic engagement led to increased trust, common norms, and networks in which the citizens in those communities had strong systems of associations. Putnam theorized that the active participation of citizens in a community built a wealth of social capita that leads to improved economic prosperity and better governance. Conversely, in regions with less evidence of civic engagement, there tended to be higher rates of crime, weaker economies, and poorer governance (Putnam, 1993).In Putnam's theory, social capital had a function and a purpose for the individual, a group, and the larger society in terms of promoting solidarity.

Putnam's theory, while widely accepted, has been criticized based on several factors. Some researchers question how Putnam assessed social capital. Putnam's emphasis on a person's participation in voluntary associations as a measure of civic engagement, which he suggested strengthened social capital, has also been questioned. Research by Stolle and Rochon (1998) found that different types of associations result in the production of varying types of capital so that participation alone does not necessarily build social capital. For example, members of political organizations have high levels of political involvement, but not necessarily high levels of trust or optimism. Different types of organizations attract people with varying interests and values, which can affect group dynamics and behaviors (Macinko & Starfield, 2001). Another criticism of Putnam's definition of capital is the lack of distinction as to whether social capital is a resource of the network, a product of the network, or an individual's response to membership in a group (Kunitz, 2004).

3.4.4 Coleman's Normative Behavior Theory

James Coleman (1988, 1994) referred to social capital as the features of a social structure that facilitate the actions of individuals within a network. Coleman considered both the individual (agent) and the structure in society in relation to creating and maintaining social capital. For Coleman, social capital is the tie between people because the inherent resources stem from those relationships. In his view, social capital is a resource in and of itself. In this theory social capital is defined by its function, which refers to the fact that social capital is not singular. Social capital can take different forms. In each form, social capital exists within social structures and as enabling people within those structures to take action (Coleman, 1994).

According to Coleman (1988), social capital is first created in the bonds that develop in families and the family acts as a person's first social organization. It is in that first social organization where people develop and use trust and reciprocity that enable family members to create, use, and sustain social capital. Children's relationship to caregivers is the foundation. The creation of human capital occurs through the social capital that is created for children by their family members. Then it is how the adult members of the family use and exchange capital outside the home that is important to the creation of social capital. It is the adult caregivers who connect their children to systems such as educational system, social systems in the community, religious organizations, and other networks that become central to the child's educational success and, ultimately, to the child's human capital (Coleman 1988).

Three forms of social capital are identified in Coleman's theory: expectation/obligation, social norms, and information channels. Expectation/obligation is where one person does something for another person (offers a favor). This obligates the receiver to return the favor at some point in time. This form of social capital relies on trust. Coleman's second form of social capital, social norms, also rely on trust. Social norms are collectively understood rules of behaviors in a network of society. The example that Coleman (1988) offers is a social norm in certain societies where young children can wander their neighborhood and it is understood that it is the responsibility of every adult to look out for them. Other types of social norms govern society such as the norm of not throwing one's trash in the street for the collective good of society. Social norms refer to the shared expectation for behaviors in any given social situation. Social capital also consists of information channels. Information channels are the relationships that enable people to find and collect information and gain access to resources. These relationships provide the conduit to knowledge that is either immediately beneficial or can be accessed and used at a later time (Coleman, 1988).

Coleman's theory most broadly considered how social capital is produced and can be created through people's actions. Once created, social capital can then take on the different forms outlined by expectations/obligations, information channels, and norms. For Coleman, simply being a member of a social organization is considered social capital. The distinguishing qualities of Coleman's theory was the inclusion of the individual (actor in a system) and the concept of social capital in terms of its creation and role in creating other forms of capital (e.g., human capital) (Coleman 1988, 1994).

3.4.5 Granovetter: Weak and Strong Ties

Granovetter's research contributed the concept of strong and weak ties in social networks (Granovetter, 1983). Social networks depend on the relationships or ties within and between people. Weak ties are typically defined as acquaintances that are less likely to be socially involved with one another. Friendships may exist in a network, but the depth of the friendship (social tie) does not necessarily create social cohesion for the group. For example, just because a person may have high number of friends and relatives in a neighborhood, the community may not be cohesive (Almeida et al., 2009). Strong ties are with people with whom a close friendship or intimate relationship exists (Granovetter, 1983). Ties, whether they are weak or strong, function to communicate information and provide capital to network members (Veenstra & Patterson, 2012). These connections are resources to both the individual and to the group, which facilitates collaboration within and between networks (Putnam, 2003).

While weak is generally associated with diminished capacity, Granovetter asserts that weak ties are actually very important in social networks. Granovetter (1983) emphasizes that there could be strength in weak ties. Weak ties are defined as more casual relationships between people in different networks. Weak ties are important because, without them people would be isolated from information and resources that are not available within their own social network. For example, an individual, Ken, has strong ties to his close friends that comprise his inner support circle. Ken has easy access to the resources and information within that close group. Nikki has strong ties to a different group. Nikki and Ken are acquaintances (weak ties to each other). Acquaintances, as compared to close friends, are more prone to move in different circles. Those within the same circles tend to have access to the same resources, which may not be as helpful. However, weak tie create an important link between the two groups through Ken and Nikki. People who act as the link between different groups (bridging weak ties) are critical because they can connect individuals who are very different from each other. This link acts as a bridge between two groups. The bridge becomes an important connection that enables the sharing of resources, information, and ideas between two groups that would not otherwise share information (Fung & Hung, 2014; Granovetter, 1983).

Weak ties are important because of the infusion of information and the access to new resources, information, and people. A weak tie to another network could be a source of help with things such as job searches, personal issues support during stressful times, and general community well-being (sharing of information, etc.) (Fung & Hung, 2014; Granovetter, 1983).

Therefore, weak ties are critical for people who are underrepresented or are segregated for any reason. Without a weak tie into other networks, people in isolated networks might not have access to the resources that are not typically available within their own networks (Granovetter, 1983). Overall, a connection, whether weak or strong, can be a source of information and a potential connection to other networks (Granovetter, 1983; Veenstra & Patterson, 2012).

3.4.6 Social Needs Perspective

Individuals, especially those who are marginalized, rely on social networks to make up for lack of individual resources (Thapa, Sein, & Sæbø, 2012). Social needs perspective suggests that strong social ties and support between neighbors *are* present and that this helps community members cope with the stressors in their lives (Almeida, et al., 2009; Berkman, et al., 2000; Carpiano, 2007; Cattell, 2001; Sampson, 2003; Veenstra, et al., 2005). Almeida et al. (2009) suggest that the presence of a common problem in a community can be the impetus for residents to work (bond) together for action. The level of trust between residents, assistance that neighbors give to each other, exchange of information, neighborhood stability, and perceptions of crime and safety can all affect the development of a cohesive social network. Almeida, et al. (2009) has suggested that the outcome of strong social support is due to both the individual (agency) and group-level dynamics where a culture of trust and reciprocity develops. This supports the existing evidence that trust is an important factor in the development of social bonds in communities (Carpiano & Fitterer, 2014).

However, it cannot be assumed that an entire network is cohesive and that all people within the community can benefit from its resources (Veenstra & Patterson, 2012). Other factors such as, available resources, opportunities for participation, and social organization/disorganization affect the development of social networks in a community. If residents don't trust each other and are not willing to help each other, this will affect the network and the overall community (Cattell, 2001).

3.5 Life Course Perspective

The concept of life course effects posits that different social ties intertwine and become accumulated over time. The integration of networks will then affect a person's decisions and behaviors (Nieminen, et al., 2013; Umberson, et al., 2010). Support and reciprocity in social networks can be short-term and/or provided over time (Berkman, et al., 2000; Ertel, et al., 2009). Social ties will change as people go through different stages. Someone who was influential in one's life as a child may not exert the same influence in adulthood (Umberson, et al., 2010).

The interrelation of factors in a network creates the network (upstream) and outcomes of the network (downstream). This cycle is created through pathways. The factors that affect the development, strength, and structure of social networks are called *upstream pathways* (Berkman, et al., 2000). The upstream factors that shape the network are structural influences, such as political, cultural, educational, and socio-economic.

Downstream pathways are defined as the links between the social networks, behaviors, and outcomes (Berkman, et al., 2000). Sometimes, influences from the different networks complement each other while at other times they may differ.

3.6 Social Capital, Social Networks, Cohesion, and Living-Learning Communities

Access to resources and imbedded benefits of a network are particularly related to Living-Learning Communities (LLCs). Living-Learning Communities facilitate the creation of social networks, the connections to peers, direct access to key faculty and staff, enhanced co-curricular learning opportunities, and links to resources. These connections directly relate to the added benefits and outcomes of belonging to the living-learning community, which may not be available to those who are not part of the community. Capital is built from and inherent to the community.

Research by Brower & Inkelas (2010) determined that students who participated in living-learning communities had access to resources with fellow students, faculty, and administrators. Students reported studying more frequently with peers, engaging in more academic and socio-cultural conversations with their peers, and interacting with faculty members on course-related topics. The students in living-learning programs also reported feeling that their residence hall had a supportive and tolerant environment (Brower & Inkelas, 2010). Brower& Inkelas (2010) \found that as students interacted more with peers and faculty, they felt more strongly supported academically and socially by their residence hall environment, and the stronger was the likelihood that they achieved the learning outcomes of critical thinking, applying knowledge outside of the classroom, being civically engaged, and experienced an easier transition into college. In addition, students in living-learning communities engaged in other ways that fostered engagement in college such as, doing research with faculty, internships, peer study groups, participating in co-curricular activities including clubs and sports, and studying abroad (Brower & Inkelas, 2010; Hixenbaugh, Dewart, & Towell, 2012; Inkelas et al., 2007; Inkelas & Weisman, 2003; Pike, Kuh, & McCormick, 2011; Rocconi, 2011; Solder et al., 2012; Stassen, 2003; Szelényi, Denson, & Inkelas, 2013; Zhao & Kuh, 2004).

3.6.1 Social Cohesion

Studies that utilized Bourdieu's theory have determined how community social capital matters. Social capital was conceptualized through the social power and cohesion of a community based on four constructs: 1) the actual or potential social network resources; 2) the levels of social cohesion in terms of mutual trust, values and interactions; 3) stability within the neighborhood; and 4) the benefits or disadvantages that social capital can offer the network (Carpiano & Hystad, 2011; Carpiano, 2008).

Social cohesion is one factor necessary for social capital to be created and accessed by members of a community (Almeida, Kawachi, Molnar, & Subramanian, 2009; Carpiano, 2008). Social cohesion can be built through trust, shared expectations, reciprocity, resources, controls, and sanctions for individuals within groups (Bjornstrom & Ralston, 2014; Carpiano & Fitterer, 2014; Frohlich, Corin, & Potvin, 2001; Nieminen, Prättälä, Martelin, Härkänen, Hyyppä, Alanen, & Koskinen, 2013; Moore et al., 2011). People who reported having close friends and/or belonging to community or organized groups benefited from the support and social influences provided through those networks (Bircher & Kuruvilla, 2014). This relates to living-learning communities because students live together in small groups in a residence hall. They share the same major or interest, have a common major-related course together (only for the members of the living-learning community), gain access to the faculty member who teaches the course in-residence, and engage in common activities. The members of the community often identify as a single group. They share resources and utilize benefits that are available only within their network.

Social capital also creates bridges to other resources, information, and people (Fung & Hung, 2014). The connections to what is available within the network and connections to other networks expand the capital and enable access to even more resources and information (Fung & Hung, 2014; Granovetter, 1983). In addition, social and economic capital can affect students' choice of or persistence in an intended major. A living-learning community for women in engineering creates an environment where there are many shared values and behaviors within and between individuals in the environment.

3.6.2 Social Networks

Social networks are the shared ties and interconnectivity of people and resources surrounding an individual. Social networks can be small or large; however, networks of all sizes may provide support, apply influence, encourage social interactions, and facilitate bonds between members (Nieminen, Prättälä, Martelin, Härkänen, Hyyppä, Alanen, Koskinen, 2013; Veenstra, Luginaah, Wakefield, Birch, Eyles, Elliott, 2005; Veenstra & Patterson, 2012). Networks form in many settings including colleges, clubs, work, religious organizations, sports teams, civic groups, political groups, and in neighborhoods (Veenstra & Patterson, 2012; Vlahov, Gibble, Freudenberg, & Galea, 2004).

As a component of social capital, social networks are understood based on the structure of a network, including the resources that are available in or flow through the network (Berkman, Glass, Brissette, & Seeman, 2000; Putnam, 2003). This considers both the person's networks and the entire connection of networks (Berkman, Glass, Brissette, & Seeman, 2000). Broadly, these networks define the social relationships and social engagements within the network. Social engagement refers to participation in activities, such as getting together with friends or joining an organized group. Behaviors are shaped by access to the support, resources, opportunities, and constraints within social networks (Ertel, Glymour, & Berkman, 2009).

Living-learning communities relate to social networks because of the inherently shared ties and access to resources that flow into and through the network. Research has also shown that supportive communities are important for student engagement and retention in college (Astin, 1984). Communities of support may be a way to help women students remain in engineering since academic achievement, alone, cannot explain why women leave engineering at higher rate than men (Galdi, Cadinu, & Tomasetto, 2014).

Within a social network, core relationships are critical as they represent stronger ties. Core relationships provide support, including emotional support, influence behaviors, and provide advice to its members (Moore et al., 2011). These different forms of support may create attachment so that, at a community level, people can feel connected to people, places, and organizations. Support can be a function of the network (Berkman, Glass, Brissette, & Seeman, 2000; Ertel, Glymour, & Berkman, 2009).

At the *individual*-level there are four primary areas that can affect people: (1) the provision of social support; (2) social influences; (3) social engagement and attachment;

and, (4) access to resources and material goods (Berkman, Glass, Brissette, & Seeman, 2000). Networks change and people participate in various networks at different points in their lives. Network ties provide different types of support, although not all ties are supportive. Support can come in the form of emotional (love, understanding, and sympathy), informational (advice or information), help with decisions, and/or assistance with 'tangible' needs (household, transportation, shopping). Friendships may exist in a network, but the depth of the friendship (social tie) does not necessarily create social cohesion for the group. For example, just because a person may have a high number of friends and relatives in a community, the community may not be cohesive (Almeida, Kawachi, Molnar, & Subramanian, 2009).

Network connections can be weak or strong (Granovetter, 1983). Ties do not need to be strong in order to be important in a network. Weak ties are typically defined as acquaintances that are less likely to be socially involved with one another. Strong ties are characterized as close friendships or intimate relationships (Granovetter, 1983). Ties, whether they are weak or strong, function to communicate information and provide capital to network members (Veenstra & Patterson, 2012). These connections can be resources to both the individual and to the group, which facilitate collaborations within and between networks (Putnam, 2003). Similarly, students within a living-learning community make connections to other groups and become conduits to expand available resources and connections between networks.

Overall, a connection, whether weak or strong, can be a source of information and a potential connection to other networks (Granovetter, 1983). An understanding of the creation and function of social networks is applicable to living-learning communities primarily because of the broad consideration of the networks and the social interconnection between people and how this directly relates to benefits and outcomes. While not all networks are supportive, there is research on the many benefits of networks and the resulting access to resources (Granovetter, 1983; Moore et al., 2011).

3.7 Student Involvement Theory

Astin's (1984) theory of student involvement considers the amount, quality, and types of activities that a student engages in for both academic and co-curricular programs in college. Research has demonstrated that student involvement in college via leadership roles, sports, student clubs, student government associations, and/or living-learning communities have a strong correlation with engagement, which can lead to educational persistence (Astin, 1984; Sax & Shapiro, 2011; Siefert, Gillig, Hanson, Pascarella, & Blaich, 2014). It is both the quality and the quantity of student engagement that can lead to retention (Astin, 1984; Astin, 1999).

Involvement in college activities, especially those that relate to academic interests, engage students in ways that make them feel connected to the institution and to others (Astin, 1999). These feelings of connection can help with transition into the demands of college including academic, social, and emotional adjustments. Higher degrees of engagement can lead to higher persistence, which positively affects student retention and college completion rates (Astin, 1999; Brower & Inkelas, 2010; Hixenbaugh, Dewart, & Towell, 2012; Rocconi, 2011). Participating in a living-learning community is a form of involvement; it forges together a group of students who have common academic interests and often participate in similar social activities. The living-learning community becomes a platform which enables students to help each other, build social capital within and between the groups, access resources, and create connections.

3.8 Summary of Theoretical Frameworks

The theories outlined in this chapter provide a framework for interpreting the quantitative and qualitative data collected and analyzed in this study. Individual motivation, group dynamics, institutional structures, the impact of these factors on the motivation, persistence, experiences, and outcomes for women in undergraduate engineering can be understood by considering the interrelation and complementary components of the theories outlined in this literature review. The theories and their components include: Modern Expectancy-Value theory (Eccles, 2013); Life Course Perspective; Social Capital/Social Networks theory; and Student Involvement theory (Astin, 1984).

Experiences that prepare students for engineering and result in a decision to major in engineering begin before a student is in high school. Based on a life course perspective, a person’s interest is formed through experiences and acquired knowledge gained throughout a lifetime. When high school students are considering what they want to do, they evaluate their own strengths and interests. Those considering engineering look at their skill in math and science. Their skills are based on experiences and knowledge gained from kindergarten through high school. In addition, any experiences they had related to building, problem solving, and the skills needed to succeed in engineering can factor into an interest in an engineering major. Further, the influences of family and close friends contribute to a decision to pursue an engineering major. All of these factors interact over time to bring a student to considering engineering.

Once admitted to an engineering school, the decision to persist can be understood though Expectancy-Value Motivation theory which is one of the major frameworks of motivation. Expectancy-Value Motivation theory considers students' self-concept and expectations of success as important factors for motivation to persist. The choice to consider pursuing and persisting in engineering is related to students' self-perception of their competence, the value they place on achievement in the coursework, and self-perception of their role in society as future engineers. The expectation of what it means to be an engineer, balanced against the efforts needed to reach that goal plus the value placed on putting in the effort to ultimately become an engineer can influence a person's persistence in the major (Eccles, 2013; Eccles, 2011).

Access to social, human, and economic capital and the connections to peers, role models, and resources (social networks) provide a framework for understanding the role of individual and group supports, trust, and reciprocity. These supports and trust, which develop in a community, can lead to better mental health, improved physical well-being, and persistence due to the supportive environment.

Finally, theories of student involvement, such as Astin's theory, propose that when students feel connected to each other and develop an identity with the college, these feelings of connection help students transition into the academic, social, and emotional adjustments associated with higher levels of independence in college and more demanding coursework. Understanding how the different theoretical frameworks contribute to the overall understanding of the different stages of a student's career in college provides insights on recruitment and retention of women in engineering and the opportunities to create an environment where women feel supported, understood, and connected.

Chapter 4: Research Methods and Design

4.1 Research Setting

4.1.1 About Rutgers

The Rutgers University fact book (2015) showed the State University of New Jersey, as the nation's eighth oldest institution of higher learning—one of only nine colonial colleges established before the American Revolution (Rutgers University Points of Pride, 2015). Chartered in 1766 as the all-male Queen's College in New Brunswick, New Jersey, the school was renamed Rutgers College in 1825 in honor of trustee and Revolutionary War veteran Colonel Henry Rutgers. In the mid-19th century, the United States Congress established the nation's land-grant colleges. In 1864, Rutgers became a land-grant institution, tasked with offering educational access to a wider range of students in New Jersey. In 1945 and 1956, state legislative acts designated Rutgers as, The State University of New Jersey. The University of Newark (now Rutgers–Newark) joined Rutgers in 1946, followed by the College of South Jersey (now Rutgers–Camden) in 1950, which gave Rutgers a statewide presence. Despite the charge to offer education to a wider range of students, Rutgers remained an all male college until 1974 (Schmidt, 1968).

4.1.2 When Women Were Admitted to Rutgers

Rutgers admitted women just after the passage of the 1972 Education Amendments of Title IX Act. In 1989, Rutgers was invited to join the Association of American Universities, making it one of the top 62 research universities in North America. In 2013 a state legislative act transferred much of the University of Medicine and Dentistry of

New Jersey to Rutgers, including two medical schools and a dental school. The integration added nine schools that comprise the Biomedical and Health Sciences, which joined the existing 18 schools and colleges of Rutgers. In 2014, Rutgers became a member of the Big Ten athletic conference and the Committee on Institutional Cooperation, a consortium of 15 world-class universities.

4.1.3 Rutgers Today

Rutgers is a top tier, co-educational, public research university, Carnegie Classification I (www.rci.rutgers.edu/~oirap/strategic/First.htm). In 2014 there were over 65,000 students on all Rutgers campuses throughout New Jersey. The New Brunswick campus had over 40,000 students with 32,206 undergraduates and 8,514 graduate students (Rutgers University, 2015). In the fall semester 2014, which was the inaugural year of the women-only engineering living-learning community, just over half of the total undergraduates were women (52.8%), which mirrored the national average. In Rutgers University – New Brunswick,, the majority of full-time students identified as White (44%). Asians represented 21%, Latino (12%), African American/Black (8%), and *other* race(5%). Foreign students comprised 10% of full-time students (Rutgers University Fact Book, 2015).

4.1.4 School of Engineering, Rutgers – New Brunswick

At Rutgers, students who intend to major in engineering are directly admitted into the School of Engineering (SOE), located on the Busch Campus in Piscataway, New Jersey. In Fall 2014, there were a total of 3,607 undergraduate students in the School of Engineering with 3,508 full-time and 99 part-time students (Rutgers University, 2014). In the fiscal year ’14 (October 2013, January 2014, and May 2014) Rutgers mirrored national data on the proportion of men and women earning Bachelor degrees in engineering with 83% (n=624) awarded to men and 17% (n=130) awarded to women (Rutgers University – School of Engineering, 2014).

The Rutgers SOE has several co-educational residence halls devoted exclusively to first-year engineering students. These residence halls are located on the Busch Campus. All engineering classes, labs, and faculty are located on there. As a result, students in engineering typically prefer to reside on the Busch Campus. After the first year, many students elect to stay on Busch campus and continue to live in co-educational residence halls designated for engineering students. In addition to the residence halls on the Busch campus, there is a STEM (all STEM majors), women-only residence hall on the Douglass Campus, five miles from the Busch Campus.

4.1.5 Douglass, the Women's College at Rutgers

To address the higher education needs of women New Jersey College for Women was founded in 1918, renamed Douglass College in 1954, and transitioned to Douglass Residential College in 2007. The founding of New Jersey College for Women was based in the political and social movements of the early 20th century. The Progressive and Suffragette movements created the climate for higher education for women. The New Jersey State Federation of Women's Clubs was a major impetus for the creation of a women's college in New Jersey (Schmidt, 1968). In 2007, Douglass College ceased to exist as a stand-alone college for women and transformed into a women's residential college with academic and co-curricular programs.

Douglass Residential College (DRC) continues its mission of supporting women in all majors at Rutgers. In 2017, approximately 2,600 undergraduate women co-enrolled in Rutgers – New Brunswick and Douglass Residential College. Douglass, as a residential college that offers academic courses, women-only residence halls, co-curricular activities, women's leadership programs and opportunities, research opportunities, community building events, career preparedness, peer and staff mentoring, and service learning opportunities for commuter and residential students. Douglass has a threefold mission: 1) provide innovative programming for women students from all backgrounds to succeed academically; 2) prepare women to thrive in the rapidly changing condition of this century's global labor force and purse career paths with confidence and conviction; and 3) prepare women to be leaders in order to contribute to solutions to environmental, economic, social justice, and technological challenges (http//douglass.rutgers.edu, 2015).

4.1.6 The Douglass Project for Women in STEM

One of the programs within Douglass Residential College is the Douglass Project for Women in Math, Science, and Engineering (Douglass Project). Established in 1986, the Douglass Project (DP) is an award-winning program that provides support and encouragement for undergraduate women pursuing degrees and careers in mathematics, the sciences, engineering, and/or technology (STEM). The goal is to increase the participation of women at Rutgers in STEM majors. The DP provides women in any undergraduate STEM major with personal, professional, research, and leadership development. Through programs and events, the staff and students in the DP offer support systems that encourage women to recognize their abilities and attain their educational goals in STEM.

4.1.7 Living-Learning Communities at Douglass

Each year a variety of themed Living-learning communities are offered through DRC and several in STEM. All of the Douglass living-learning communities are for women only. The participants live together in university residence halls for the full academic year and take a for-credit academic course in residence. Commuter students can participate in some of the Living-learning communities and service learning opportunities.

Commuter students cannot participate in the Reilly-Douglass Engineering Living-Learning Community. Each DRC living-learning community enrolls between 12 to 18 women, with the exception of the Reilly-Douglass Engineering Living-Learning Community, which enrolled 20 students in its inaugural year and steadily increased enrollment up to the current number of 32 students each year. There is also a DRC living-learning community in partnership with the Honors College which started in 2015 and co-enrolled increasingly more women in both the Honors College and DRC each year. The first year 60 Honors College women co-enrolled in DRC and each year, there were more students joining. The DRC living-learning communities are formed based on students' interests or majors: language, culture, arts/creativity, leadership, human rights, business, engineering, computer science, environmental studies, public health, media, and medicine.

All of the living-learning communities have an academic course linked to the interest of the house. Subject-matter experts for that discipline teach the linked academic courses. A faculty member from the RU-NB School of Engineering teaches the engineering course for the women in the Reilly-Douglass Engineering Living-Learning Community. The various communities are not all in the same residence hall or on the same campus, but the majority of them are located on the Douglass campus. The Reilly-Douglass Engineering Living-Learning Community is a women's-only floor in a first-year co-educational residence hall on the Busch Campus in Piscataway, New Jersey.

4.1.8 The Women-Only Engineering Living-Learning Community

The Reilly-Douglass Engineering Living-Learning Community resulted from a partnership between DRC and the Rutgers SOE. It was opened in 2012 with 20 first-year women who, upon admission to college, indicated that they intended to major in engineering. Established as a first-year living-learning community, the community was placed on the Busch campus, the hub of engineering activity at RU-NB. Enrollment in the Reilly-Douglass Engineering Living-Learning Community is voluntary and via an application. The community is filled based on a first-come/first-served basis. The students lived together in a women-only wing of a co-educational, first-year engineering residence hall. The living-learning community has a mandatory in-residence engineering explorations course (academic course) taught by a woman engineering faculty member. Other components of the living-learning community are connections to research opportunities as early as the second semester of the first year, special events such as field trips and networking opportunities sponsored by corporations, connections to alumnae/I, internship and/or job shadowing experiences, and a multi-layered mentoring program that connected the students to peers, graduate students, faculty, and staff.

Since its inception in 2012, the Reilly-Douglass Engineering Living-Learning Community has increase. There were 22 first year women enrolled in the fall 2013, 31 entered in fall 2014, and 34 in fall 2015. Each year, proportionately more women enter engineering at Rutgers However, the living-learning community has a cap on enrollment.

More applications than placements are received each year, but due to space limitation in the residence hall, students were placed on a first-come, first-served basis until the designated wing in the residence hall is filled with no more than 34 students per year. The students who are not selected for the Reilly–Douglass Engineering Living-Learning Community have the residential option of a women-only STEM residence hall on the Douglass campus or not affiliating with Douglass and choosing the co-educational residence hall on the Busch campus. There are commuter women in engineering. Commuter students can enroll in Douglass, but not in the Reilly-Douglass Engineering Living-Learning Community because of the first year residency requirement for the Reilly-Douglass Engineering Living-Learning Community.

The formation of a Douglass community on a campus outside of the Douglass campus was the first time that Douglass expanded its footprint at Rutgers. This was also the first time that a community of women was located within a co-educational residence hall rather than a full women-only residence hall. In 2017, three such communities existed: Reilly-Douglass Engineering Living-Learning Community (inaugural year 2012), the Douglass DIMACS Computer Science Living-Learning Community on the Busch campus (inaugural year 2016), and a community of women in the Honors College on the College Avenue Campus (inaugural year 2015). An all-STEM community for any STEM major remains on the Douglass campus with over 100 students.

While the Reilly-Douglass Engineering Living-Learning Community was originally intended as a first-year-only community, at the end of the first year, the first cohort of students asked to continue to live together into their second year. Undergraduate Academic Affairs enabled them to secure housing in another engineering residence hall on the Busch campus, if they chose to continue living together as a cohort in their second year. They were assigned a hallway in a different co-educational residence hall on Busch campus. Concurrently, a new class of 22 first-year engineering women were recruited for fall semester 2013 and lived together in the initial first-year-only Reilly-Douglass Engineering Living-Learning Community that the inaugural cohort had entered into the prior year. In fall 2014 and fall 2015, the first year Reilly-Douglass Engineering Living-Learning Community was expanded to accommodate more incoming students and each year they transition as a cohort into a different residence hall making way for the new students to join the community. Each cohort year was considered part of the full Reilly-Douglass Engineering Living-Learning Community so that in the fourth year (fall 2015) the community was comprised of all levels from first year through graduating seniors.

DRC has a long history of supporting women's education, supporting women in STEM, and creating a community of support. The Reilly–DELLC was one example of this support and could be important in potentially addressing the underrepresentation of women in engineering. This program evaluation, as a case study, provides important information regarding the recruitment and retention of women in engineering.

4.2 Areas of Inquiry

The primary area of inquiry focused on assessing the effectiveness of the women's-only Reilly-Douglass Engineering Living-Learning Community. Given the history of women's colleges being effective in promoting women's leadership and success, it was important to assess the effectiveness of a women's-only living-learning community for the recruitment and retention of women in undergraduate engineering. Both qualitative and quantitative data were collected in this mixed-method program evaluation.

4.3 Research Design

This study was a program evaluation conducted as a case study with the following components: 1) quantitative analysis of student retention and achievement; and 2) qualitative data collected through individual interviews. A mixed methods design allowed for more complicated research questions to be addressed with a stronger collection of evidence than would be obtained via any single method (Yin 2014). A mixed method approach also enabled multiple converging inquiries to substantiate the findings (Yin, 2014). Further, case studies have been used with success in understanding other living-learning communities within universities (Inkelas, 2011; Pace, Witucki, & Blumreich, 2008; Zundl, Stiltz, & Buettner, 2015).

4.3.1 Quantitative Design

Using a quasi-experimental design there was a treatment group (the Reilly – DELLC); and two non-equivalent control groups: 1) women engineering students who were not in the Reilly–DELLC and 2) male engineering students. This was a case study that included student information from high school and college. The time period was fall 2012 through fall 2015, which involved four cohorts of Reilly-Douglass Engineering Living-Learning Community students in the sample. Multivariate statistical methods were used to estimate the impact of the Reilly-DELLC, and to adjust for potential confounders.

4.3.2 Qualitative Design

The qualitative data collected through individual interviews provided information about student experiences in the Reilly-Douglass Engineering Living-Learning Community, the School of Engineering, and at Rutgers-New Brunswick, overall. Individual interviews allowed sensitive topics to be discussed and revealed themes were analyzed using underlying theoretical frameworks of social networks as a form of social capital, expectancy-value motivation theory, student involvement, and the role of living-learning communities as a potential tool for the retention of women in engineering. Appendix A contains the specific questions for the semi-structured individual interviews, as approved by the Institutional Review Board at Rutgers University – New Brunswick.

Participants were advised that the interview would last approximately one (1) hour. Some students completed the interview in an hour or less. Others were engaged in the interview for over two hours. A total of twenty-one (21) students were individually interviewed. The participants represented each of the cohorts of students admitted each fall semester from 2012 to 2015, and one student who had left the program and left the university.

The rationale for this selection was that the students who entered in fall 2012 represented the first group of students to enter and the only cohort to have graduated from the Douglass engineering community during the time of this study. The students who had entered in fall 2012 were exposed to the resources, information, and networks for the longest period of time. The graduating seniors had a perspective that no other students could have had regarding the program as they participated for four full years. At the opposite end of the spectrum were the most recent students (first year engineering students) who entered the program in fall 2015.

The engineering living-learning community was originally designed as a first-year experience and the majority of resources have been geared towards the first year. Therefore, it was important to capture the qualitative data from the students who were just completing their first year. The sophomores entered the Rutgers School of Engineering and enrolled in the Reilly-Douglass Engineering Living-Learning Community in the fall semester of 2014. The end of the second year for undergraduate engineering students at Rutgers is an important milestone because students must declare their major by identifying the engineering department with which they will affiliate by the beginning of the second year. Therefore, the quantitative and qualitative data collected at the end of the sophomore year identified the students who were retained in college and in the specific engineering major for one full year after declaring the major.

All students at the Rutgers School of Engineering start with the major of *Engineering-4 Year*, the equivalent of an engineering major but not the specific discipline. At the end of their first year in the School of Engineering, all students must identify which area of engineering they will declare. Rutgers offer eleven engineering majors: applied sciences in engineering, bioenvironmental engineering, biomedical engineering, chemical and biochemical engineering, civil and environmental engineering, electrical and computer engineering, energy systems engineering (newly added in fall 2017), industrial and systems engineering, materials science and engineering, mechanical and aerospace engineering, and packaging engineering. A description of each program in engineering is included in Appendix D.

The specific major, officially recorded in the student's transcript, was stored in the Student Record Database administered by the Office of the Registrar. Declaration of the specific department (discipline) within engineering is identified no later than the end of the second year in the 4-year engineering program. Declaring a specific engineering major at the end of the second year was one indicator of a student's intention to remain in engineering.

Students who were in their third year (Junior) provided information that was more focused on future plans for graduate school and/or the workforce. All interviews were conducted in the second semester of this year to identify student intentions to remain in engineering. The students in their senior year were the first cohort in the Reilly-Douglass Engineering Living-Learning Community and were on the verge of graduating. They provided the most information about a four-year engineering experience. One student from that cohort, who had dropped out of the program in her first year, agreed to be interviewed. She had left the university and did not pursue engineering or any major at any other college.

For the qualitative data analysis all 21 interviews were recorded with a voice recorder and transcribed into written format. The recorded interviews were transcribed and then uploaded into Nvivo, a commercial software product, for the management of qualitative data. Nvivo was used to code the interviews and analyze the qualitative data for emergent themes. To incentivize participation, small gifts were given at the end of the interviews. The student had a choice of either a water bottle or mug and received a pen and magnet in a paper gift bag.

4.3.3 Human Subjects

Protection of the research subjects and all participants was guaranteed through obtaining and appropriately renewing Institutional Review Board approval from the Office of Research and Sponsored Programs at Rutgers University. The requisite training was completed prior to data collection. Participants were informed that any information that may have been obtained at a prior time (as a participant or participant-observer given my role at Rutgers/Douglass) would not be included. Any information obtained that did not directly related to this study was excluded from the research data (Semel, 1994).

4.3.4 Data Sources

Quantitative data were provided from three offices at Rutgers – New Brunswick: Admissions, Financial Aid, and the Office of the Registrar. Written authorization was obtained from each office prior to the release of the data to the researcher. Once approved, the Offices of Institution Research and the Admissions Office provided the information. Data were extracted from the Student Record database for gender and the college transcript included college grades overall, grades in engineering and pre-requisite courses, individual semester GPA, overall GPA, and the number of semesters the student was enrolled. Student financial data, such as family income, were obtained from the Office of Financial Aid, Rutgers University – New Brunswick.

Data that could only be obtained at the time of admission to the university, including all SAT scores, high school attended, type of high school, residency, high school GPA, and high school grades in math and science classes was provided by the Enrollment Services Office (Office of Undergraduate Admissions) at Rutgers University

– New Brunswick. Data were then integrated into one dataset (Microsoft Excel) using matching records based on the unique Rutgers University Identifier (RUID).

Since high schools reported grades differently (in letter grades, in number grades, or in percentages), the data were cleaned. Other data needed to be cleaned. For example, when the University renamed "Mechanical Engineering" to "Aerospace and Mechanical Engineering,"), SPSS considered the two different names and counted them as two different majors. Therefore, it was necessary to combine these majors into the one discipline named, "Aerospace and Mechanical Engineering."

Also, Douglass students were indicated with a special coding that was applied by the Office of the Registrar. This was done via a manual entry into the Student Record Database. Some of the students in the Reilly Douglass Engineering Living-Learning Community were missing the Douglass code ("D") in a field on their transcript (Office of the Registrar). This was likely due to simple human error since staff in the Office of the Registrar entered the Douglass code, manually. The full dataset was then imported into SPSS in order to run statistical analyses. Table 4 lists the control and outcome variables for this research.

Table 4. Research Variables and Data Sources

Control Variables	Outcome Variables	Source of data

• **Gender**
 	
• **Student Type:**
  • Women
    ○ in Reilly DELLC ♀
    ○ **not** Reilly-DELLC
  • Men
 	
• **Ethnicity**
 	
• **High School Achievement**
  • SAT: Math, Verbal, Combined
  • Overall H.S. GPA
	• **Retention in Engineering**:
	  • Year 1
	  • Year 2
	
	• **College Achievement**:
	  • Engineering GPA
	
	• **Experiences**
	  • Self-reported experiences all years (Reilly-DELLC)
		• **Rutgers data**:
		  • Admissions
		  • Enrollment
		  • College transcript
		  • Financial Aid
		
		• **Individual interviews**

The outcome variables related to persistence and academic performance:

1. Retention in engineering. Students needed to declare their specific engineering discipline by the spring of their first year. Students who persist through the first two years (first four semesters) of engineering do not typically drop out of an engineering major after their second year. Therefore, the outcome measures were:
    a. Whether or not a student was retained in engineering by the end of year one (1);
    b. Whether or not a student was retained in a declared major of engineering by the end of year two (2);
    c. Whether or not the first cohort of students (entered fall 2012) in the Reilly-Douglass Engineering Living Learning Community were retained in an engineering major for four years (Seniors).

d. Whether or not the students that entered fall 2012 and enrolled in the Reilly-Douglass Engineering Living Learning Community reached the fourth year and ready to graduate in May 2016 (4 year completion).

2. Grades: Achievement in college as measured by engineering GPA at the end of year one (semester two) and at the end of year two (semester 4).

4.3.5 Sample

The sample was comprised of subjects who were undergraduate students, both men and women, who entered as first-year students in fall 2012, fall 2013, fall 2104, and fall 2105. Inclusion criteria were:

a. students (women and men) in the School of Engineering at Rutgers University;
b. admitted as first-year students (can be any age provided they were admitted directly into engineering as first-year, not transfer students)
c. full-time students;
d. any intended engineering major;
e. after declaring a major, any engineering major offered through the School of Engineering, New Brunswick campus.

The total sample consisted of 2,970 students, both male and female. Table 5 provides information about the proportion of men and women enrolled during the time period of this study. The participants were matched cohorts based on their enrollment with data obtained from admission records. Participants were incoming, first year students in one of three comparison groups from each of the target years 2012 through 2015:

1) undergraduate women in engineering who were enrolled in the Reilly-Douglass Engineering Living Learning Community;
2) undergraduate women in engineering but were not enrolled in Reilly-Douglass Engineering Living Learning Community;
3) undergraduate men enrolled in engineering.

Table 5. Total Enrollment of First-time, Full-time Men and Women in Rutgers School of Engineering, Fall 2012 through Fall 2015 by Gender

Gender	Count	Percent
Women	695	23.4
Men	2275	76.6
Total	2970	100.0

Data sources: data set provided in excel format for student demographic and student transcript information from the Office of Institutional Research, Rutgers University-New Brunswick, fall semester 2016.

4.4 Statistical Analyses

Statistical analyses were conducted using SPSS software (version 25 for MAC). Descriptive analyses used frequencies, cross tabulations, means, and standard deviations. Multivariate analyses were conducted using multiple regressions for continuous outcome variables (engineering achievement as measured via college grade point average in engineering major courses), and multiple logistic regression for dichotomous outcome variables (retention in any engineering major in the Rutgers-New Brunswick School of Engineering).

4.5 Role of the Researcher

As the Associate Dean at Douglass Residential College, Rutgers University, through all phases of this study, I was aware of my potential impact on the participants and attempted to limit that impact. As I am employed at Douglass Residential College, I was a participant, a participant-observer, and a researcher. Through all phases, I distinguished between my role as a researcher (and student of Rutgers) and my role in the administration of the Reilly-Douglass Engineering Living-Learning Community program and my larger role as the Associate Dean of Student Programs at the college in which the Reilly-Douglass Engineering Living-Learning Community was jointly administered.

There are difficulties in doing research as a participant and participant-observer (Semel, 1995; Semel 1994). Given my presence with students, I attempted to limit my impact on participants during the interviews (Belichesky, 2013; Semel, 1994). In addition to my involvement with the students, I also knew most of the administration and faculty involved with the Reilly-Douglass Engineering Living-Learning Community. Because of my personal involvement in the college, I was aware of the significant methodological concerns that my relationship to the participants can pose (Semel, 1995; Semel 1994).

Semel (1995, 1994) through her own research as a former participant, participant-observer and researcher cautions those who conduct research in situations where they are also participant to consider several factors. First, I do recognize that I was part of the institution and that I inherently have my own subjectivity. As I maintained a direct reporting relationship to the Dean of Douglass and I worked closely with the staff that runs the program, I needed to be cognizant of my own feelings about the program and the personnel throughout my research. As I gathered data, I needed to understand how my own perceptions may/may not have contradict the evidence that I gathered about the academic, social, co-curricular program, its students, and the administration. I knew that I had to be aware of researcher bias, ethical dilemmas, and potential conflicts which may have arisen because of my role in administration, as a participant-observer, and as a researcher for this program (Belichesky, 2013; Semel, 1994; Yin, 2014).

Guided by the work of Semel (1995; 1994), I was mindful of the need to look critically at the program, the leadership, and the organization. I was aware of my own perceptions of what I believed to be outcomes of the program for the students and for the institution. I was continuously sensitive to the fact that I was an insider. As such, I may have had access to information and knowledge that shaped my research. This was important as it may have provided insights that others might not have had access to (Semel, 1994). I also considered my impact on the research and factored in how others may have responded to me.

Despite my role in administration, I was not involved in the day-to-day operation of the Reilly-Douglass Engineering Living-Learning Community, the advisement of the students, or the academic programming. However, I was aware of the ethical issues of mixing information that I obtained as a participant with information that I obtained as a researcher. I was attentive to not including information from private conversations or observations in which I was a participant (Semel, 1994).

Being an employee did help to provide access to the participants and to resources. However, these existing relationships may have introduced a possibility for subjective interpretation of the data and may have created a potential for bias. Establishing rapport during the interviews may have been facilitated because of my role in administration at Rutgers/Douglass. However, I was aware of the need to keep my perspective as researcher during those times (Semel, 1995, 1994).

Chapter 5: Quantitative Results

5.1 Introduction

The purpose of this study was to evaluate and compare the academic outcomes of women in engineering who participated in a women-only, engineering living-learning community at a four-year university. The comparison groups were women in engineering (but not in the Community) and all men in engineering at the same university. This study focused on the pilot years from the 2012 inaugural year of the women-only engineering living-learning community through four years later in May 2016, near the time of graduation.

The setting was Rutgers University, a large, Big 10 public research university located in New Jersey. The campus was Rutgers-New Brunswick. The living-learning community (also referred to as: the Community; the Reilly Douglass Living-Learning Community; Reilly-DELLC; or R-DELLC) was located on the Busch Campus in Piscataway, New Jersey.

In this chapter, data for the three groups of incoming, undergraduate engineering men and women were presented and analyzed. The control variables were gender, ethnicity/race, and high school achievement. High school achievement was defined as Scholastic Aptitude Test (SAT) Verbal score, Scholastic Aptitude Test (SAT) Math score, and overall (converted) high school grade point average. Information about the participants included the type of high school attended and intended major which was collected from the admissions applications for each participant.

Guided by the research questions, an overall goal of the evaluation was to better understand the academic outcomes of students enrolled in undergraduate engineering in the School of Engineering at Rutgers University - New Brunswick. Data included high school academic profiles, demographic information, academic achievement in college, and retention in an engineering major for each of the three groups of students. Outcomes were: i) enrollment in the school of engineering, ii) retention in engineering, and iii) college grades in engineering.

5.2 Data Collected

The quantitative data that were collected for this study were comprised of demographic and academic information obtained from admission records and college transcripts. Admissions data included high school grades, overall high school grade point average, scores on the SAT Verbal and SAT Math tests, overall SAT score, student ethnicity, type of high school attended, student residency, intended major, year of entry, and gender. College data, collected from the college student record database, included college grades in math and science courses, semester grade point average, overall college grade point average, total number of semesters enrolled, retention in engineering as determined at the end of year one and year two, and enrollment in the Douglass Engineering Living-Learning Community. The data were collected with the intention of answering the research questions that guided this study:

1. Does a women's-only living-learning community affect the recruitment of women into engineering?
2. Does participation in a women's-only living-learning community affect the retention of students in the engineering living-learning community at Rutgers?

3. How do the undergraduate women in the Reilly-Douglass Engineering Living-Learning Community compare academically with men and with undergraduate women in engineering at Rutgers University-New Brunswick who were not in that Community?
4. How do participants in the Reilly-Douglass Engineering Living-Learning Community program experience the community including its strengths and weaknesses?

The study was conducted using data collected from Rutgers University – New Brunswick for students enrolled in the School of Engineering. The students were grouped: i) women enrolled in the women-only engineering living-learning community; ii) women enrolled in the same years in engineering, but not in the living-learning community; and, iii) men enrolled in the same years in engineering, not in a living-learning community. Quantitative data were obtained from the Rutgers-New Brunswick Office of Enrollment Management. Data were downloaded from two different databases with permission from the School of Engineering, the Rutgers Registrar's Office, and the Office of Enrollment Management (Admissions). The data were combined into a single dataset keeping a unique identifier for all records. All statistical analyses were completed utilizing IBM SPSS Statistics Software 25.

5.3 Participant Profile

The participants in this study were first-time, full-time students enrolled in the undergraduate engineering degree from fall semester 2012 through spring semester 2016. The women-only engineering Community was located in a wing on the fourth floor of a co-educational residence hall for all first-year engineering students (men and women). Others referred to the wing of the residence hall as the “Douglass girls” floor.

Excluded from this study were part-time students, non-matriculated students, students in an engineering major from any other school within Rutgers, post-secondary students, and graduate students. The justification for the exclusions were that this study focused on full-time, first-year undergraduate students admitted to the School of Engineering. The exclusion of part-time and non-matriculated students enabled comparisons between the students enrolled in the Reilly-Douglass Engineering Living-Learning Community and all other first-time, full-time engineering student.

5.3.1 Student Demographics

5.3.1.1 Race/Ethnicity

Table 1 shows engineering enrollments of men, women not in Reilly-DELLC, and women in Reilly-DELLC by the five categories for race/ethnicity that were collected at Rutgers University. Asian/Pacific Islander and White students accounted for 85% of all enrolled students in engineering. Almost half (47%) of all engineering students enrolled between the fall 2012 and fall 2015 self-identified as Asian/Pacific Islander. The next most frequently enrolled racial/ethnic group was students that identified as White with total of 38% of all enrolled engineering students.

Racial/Ethnic diversity revealed statistically significant differences ($p \leq 0.003$) between the three groups of students: men, women not in the Reilly-Douglass Engineering Living-Learning Community, and those women in the Community. The

Community was diverse. Proportionally, there were more "not-White" students (56%) in the Reilly-Douglass Engineering Living-Learning Community than White women. Women who identified as Black/African American comprised 9.4%, LatinX (Puerto Rican and Latina) represented 8.8% of the students, Asian/Pacific Islander students were 39.6%, and there was one Native American student (.9%). Women who identified as White comprised 43.4% of the women-only engineering Community.

Table 6. Characteristics of the Study Subjects
(N=2970)

Variable	Value	Men		Women				All Students		Chi-square	p-value
				Not Reilly-DELLC		Reilly-DELLC ♀					
		N	%	N	%	N	%	N	%		
Enrollment Year	2012	601	79	139	18	20	3	760	100		
	2013	558	79	127	18	22	3	707	100		
	2014	570	75	159	21	31	4	760	100		
	2015	546	74	164	22	33	4	743	100	9.84	.016
Race/ Ethnicity	Asian/ Pacific Islander	1042	46.2	319	55	42	39.6	1403	48		
	White	895	39.7	182	31.4	46	43.4	1123	38		
	Black/ African American	105	4.7	30	5.2	10	9.4	145	5		
	LatinX (Puerto Rican, Latina/o)	206	9.2	47	8.1	7	6.6	260	9		
	Native American	7	.2	2	.3	1	.9	10	.3	12.95	.003
Type of High School	Public	1769	78	462	79	86	81	2317	78		
	Special/ Technical (Public)	194	9	47	8	5	5	246	9		
	Other	306	13	79	13	15	14	400	13	2.05	.726

It was also noted that there were proportionately more Black/African American women enrolled in the Douglass engineering community as compared to men and to all other women not in the Community between 2012-2015. Students who identified their race/ethnicity as White comprised 43% of the Reilly-Douglass Engineering Living-Learning Community. Proportionately there were more White women represented in the Reilly-Douglass Engineering Living-Learning Community than were represented in either of the other two groups of students (men and women not in the Community). Regarding the other races/ethnicities of students, those who reported their race/ethnicity, as Asian/Pacific Islander was slightly lower in the Reilly-Douglass Engineering Living-Learning Community as compared with all other students in the School of Engineering. Only six percent (6.6%) of women in the Reilly-Douglass Engineering Living-Learning Community identified as Latina, which was fewer as compared with all other students in engineering at Rutgers.

5.3.1.2 Enrollment

Figure 5. Change in Enrollment Count, 2010-2015
(N=3489)

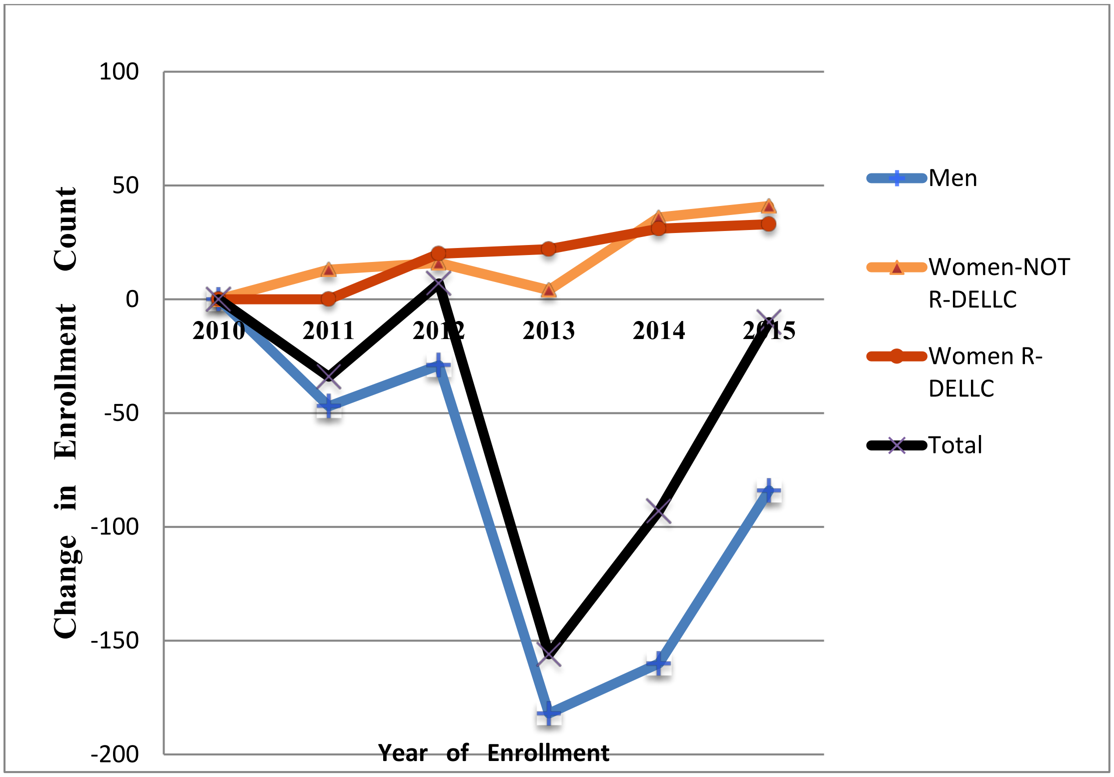


Figure 1 shows the statistically significant (p=.016) increase of women that entered undergraduate engineering over the four year time period. Within those four years, while the entering class of all engineering students (men and women) was slightly smaller than prior years at Rutgers, the percentage of all *women* increased by 24% from year one (2012) to year four (2015). There was a decrease of nine percent (9%) in enrollment of men from year one (2012) to year four (2015).

While it was interesting to note the differences in the type of high school attended, there were no statistically significant differences found between the three types of student groups regarding the type of high school they attended (p = .726).

5.4 Intended Major

The School of Engineering at Rutgers University – New Brunswick offers ten (10) engineering majors. The description of each major at Rutgers University-New Brunswick is provided in Appendix D. In addition to ten engineering options, there was also the choice of "engineering undecided" as an intended major.

Students had the first opportunity to identify an engineering discipline that they intended to pursue when they filled out the application for admission to Rutgers University, School of Engineering. Then, upon enrollment in their first semester, engineering students were assigned the major, "Engineering Four Year." Declaration of the specific engineering major typically happens by the end of the first year. The declared major does not have to be the same as the major that they intended at the time of admission. During the fall semester of the first year, students had the opportunity to learn about the different engineering disciplines before needing to identify the specific department with which to affiliate at the end of their first year (spring semester).

All incoming students took an orientation to engineering or exploration of engineering course in their first year. These introductory courses expose students to the options for engineering majors, prior to the specific discipline being declared. First year student also enrolled in the same math and science courses in preparation courses for upper-level engineering courses that will be taken in subsequent years.

Table 7. Distribution of Intended Engineering Majors for Incoming (First Year) Students, Fall 2012-Fall 2015
(N=2970*)

	Men	**Women NOT R-DELLC**	**♀ Women R-DELLC**	**Total**

Intended Major	N	% within type	N	% within type	N	% within type	N	% of Total
Applied Science	45	2.0%	14	2.4%	0	0%	59	2%
Bio-Environmental	20	0.9%	10	1.7%	4	3.8%	34	1.2%
Biomedical	350	15.5%	212	36.4%	33	5.5%	595	20.2%
Chemical/ Bio-Chemical	204	9%	70	12%	15	14.2%	289	9.8%
Civil/Environmental	231	0.2%	60	3%	8	7.5%	299	10.2%
Electrical/Computer	559	24.8%	88	15.1%	12	11.3%	659	22.4%
Engineering MBA 5yr.	21	0.9%	4	0.7%	1	0.9%	26	0.9%
Industrial/Systems	45	2%	18	3.1%	5	4.7%	68	2.3%
Materials Science	34	1.5%	3	0.5%	2	1.9%	39	1.3%
Mechanical/ Aerospace	577	25.6%	62	10.7%	18	17%	657	22.3%
Undecided Engineer	70	7.5%	41	7%	8	7.5%	219	7.4%
Total	2256	100%	582	100%	106	100%	2963	100%

Chi-Square: $\chi^2(20, N=2944)=207.73^{**}$, p = .000
*Missing Cases=26.
**5 cells (15.2%) had an expected count less than 5. The minimum expected count was 0.94.

Table 7Table 7 shows a significant difference (p=.000) between gender and choice of intended major. Of the 11 options, including “undecided,” men chose five of the majors at higher rates than women. Applied Science had equal proportions of men and women, but, overall, it was not a popular major with relatively few students over the four years indicating an interest in pursuing Applied Science.

As indicated in

Table 7, men predominated in the overall two most popular majors: Electrical /Computer Engineering and Mechanical/Aerospace Engineering. The major most identified as an intended major was Electrical/Computer Engineering with 22.4% (n=659) of all student indicating that major on the admissions application. The gender distribution for the Electrical/Computer Engineering major revealed that men were 1.7 times as likely to choose that major with 14.5% of all women (n=100) and 24.8% (n-559) of all men choosing Electrical/Computer Engineering from among the engineering major choices.

Mechanical/Aerospace Engineering was the second most identified intended engineering discipline with 22.3% of all students identifying that major. It was almost as popular as the number one intended major (Electrical/Computer Engineering) since there were only two fewer students intending to major in Mechanical/Aerospace Engineering over the four year time period. Men selected Mechanical/Aerospace Engineering 2.2 times as often as women with 25.6% men and 11.6% women. These findings suggested that Mechanical/Aerospace and Electrical/Computer Engineering will continue to have fewer women in the educational pipeline and ultimately in the workforce since fewer women considered this discipline from the onset.

The most identified intended major for women was Biomedical Engineering. While it was the overall third most popular intended major overall, for women it was the top intended engineering discipline. Women indicated an intention to pursue Biomedical engineering 2.3 times as often as men. The gender break down was 35.6% of all women selected that major while only 15.5% of all men identified an interest in Biomedical Engineering.

Women were also the proportional majority in the following additional three engineering disciplines, listed in order of majority:

1. Bio-environmental Engineering was identified by only 34 students in the four year time period and was the least frequently identified major ranking ten of

ten on the list. However, it was the second most popular intended major for women, choosing it 2.2 times as often as men. The gender breakdown was 2% of all women and 0.9% of all men intended to select Bio-environmental engineering;

2. Industrial Systems Engineering was ranked as seventh to be selected out of the ten majors among all students admitted from fall 2012 through fall 2016, but it was the third most identified major for women. Women identified this major 1.7 times as often as men. With a total of 68 incoming students identifying Industrial Systems over the four year time period, women identified that major 3.3% of the time and men selected that major 2.0% of the time; and
3. Chemical/Bio-chemical Engineering was the overall fifth most identified intended major out of the eleven options identified by all students, but was the fourth most popular for women. There were 289 students in the four-year time period listing this major as their intended major. Women selected this intended major 1.4 times as frequently as men. The analysis by gender was 12.4% all women and nine percent (9%) of all men indicated this as an intended major from among all choices.

5.4.1 High School Academic Achievement

5.4.1.1 Grade Point Average

High School Grade Point Averages (HS GPA) were a measure of academic achievement and used by colleges to predict success in college. In this study, High School Grade Point Averages ranged from 0.00 to 4.50. Zero was failing and 4.50 represented 100% (plus). The “plus,” from 4.01 to 4.50 GPA, accounted for weighted averages factored into the GPA for high school advanced placement and honors classes. The Rutgers Undergraduate Admissions Office also performed a mathematical conversion of high school grades into a consistent format because grades were not reported uniformly by each high school. High schools reported letter grades, number grades, or percentages. Therefore grade point averages were standardized for all students. This section provided an analysis of high school academic achievement by gender.

Figure 6 shows a "box and whisker" plot that compared the distribution of high school GPA between the three groups of students, reported as the median and quartiles. The box plots visually indicates comparisons between the three groups for the range of high school GPAs, the quartiles that the grades fall within, the median grades for each of the three groups, and the mean grades for each of the three groups including the minimum and maximum scores. The line inside the box represents the second quartile, which is the median of the grades. The box represents the students that fell between the first and the third quartiles. The box below the line was where 25% of the grades were expected to fall. The box above the line is where it was expected that 75% of the grades would fall. The line inside the box was not in the center of the box because it represented the middle point (median) grade in the data. The vertical lines and whiskers represented the outlier grades that fell below the 25th percentile and above the 75th percentile of grade point averages. Table 8 shows the means, medians and standard deviations of the students' high school GPAs.

Table 8. Distribution of High School Grade Point Average
(N=2970*)

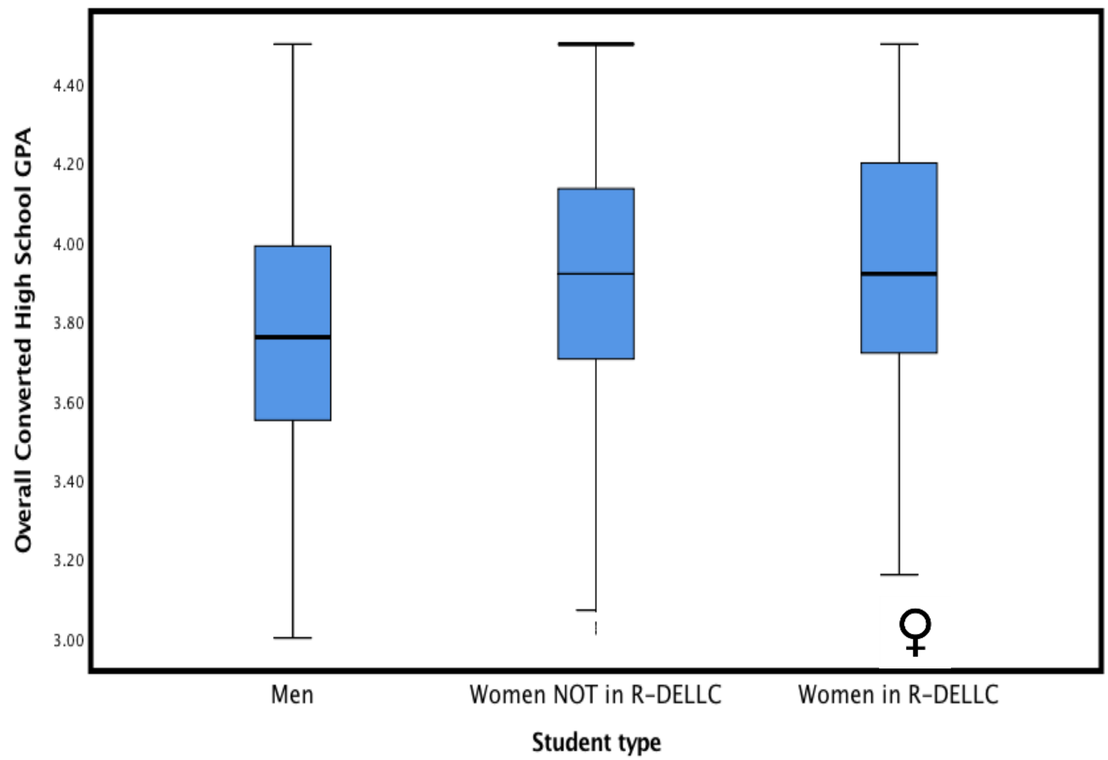
Student Type

High School Grade Point Average	Men (n=2248)	Women NOT in R-DELLC (n=579)	♀ Women in R-DELLC (n=105)
Mean	3.76	3.91	3.93
Median	3.76	3.92	3.92
Standard Deviation	.347	.326	.313
Minimum	1.42	2.68	3.16
Maximum	4.50	4.50	4.50
*Missing Cases=38			

Women, whether or not they enrolled in the Reilly-Douglass Engineering Living-Learning Community, had a similar profile to each other for high school GPA. The median HS GPA for both groups of women was the same (median = 3.92) and there was a much smaller range of scores of overall GPA as compared with the men. However, there was a difference in the range of scores between women in the Reilly-Douglass Engineering Living-Learning Community and all other women.

Women in the Community had an average minimum GPA of 3.16 that was higher than all other women. Women who were not in the Community (all other women in engineering) had an average minimum HS GPA of 2.68. And, as a group men were even lower at 1.42 as the lowest minimum HS GPA. It was also noted that the women in the Reilly-Douglass Engineering Living-Learning Community had a slightly higher overall mean high school GPA (mean=3.93) than all other women (mean=3.91) who entered engineering from fall 2012 through fall 2015. This indicated that there were significant academic differences between the three groups at the time of entry to Rutgers.

Figure 6. Box Plot Quartile Distribution of High School Grade Point Average by Student Type
(N=2970*) *Missing Cases=38



On average, men had a lower overall HS GPA than women and men had a wider range of grades. The median grade point average for men was 3.76 in the range from a 1.00 to a 4.50 GPA. An Analysis of Variance (ANOVA) was used to compare the three groups of engineering students (not shown). Overall, men had a significantly (p=.000) lower High School Grade Point Average than all women (both the women who were in the women-only engineering Community and women who were not in the Community).

5.4.1.2 High School Achievement: Scholastic Aptitude Test

Scholastic Aptitude Test (SAT) scores were another factor in the control variable of high school academic achievement. Colleges use SAT scores to predict academic success in college. The combined SAT was comprised of the math score and the verbal score (800 points each for a total maximum score of 1600). There was no writing section for the

SAT included in this composite score. Figure 7 showed that women in the Reilly-Douglass Engineering Living-Learning Community had average combined SAT scores that were lower than the men and below that of the other women in the School of Engineering who were not in the Community. ANOVA (not shown) identified significant mean differences (p=.000) in combined scores (math and verbal tests) of the Scholastic Aptitude Test (SAT) between the three types of students.

Figure 7. Box Plot Quartile Distribution of Combined Verbal/Math SAT Scores
(N=2970*) * Missing cases=127

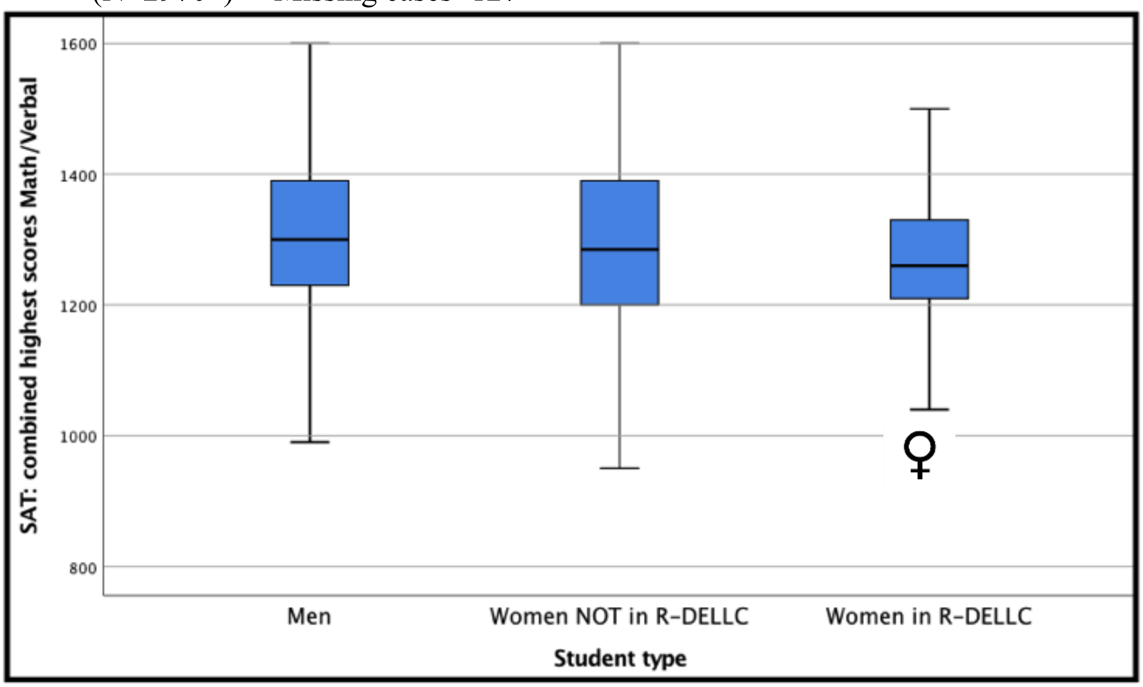


Table 9. Distribution of Combined SAT Math and Verbal Scores (SAT)
(N=2970*)

	Student Type		
SAT Combined Highest Scores Math/Verbal	**Men (n=2190)**	**Women NOT in R-DELLC (n=555)**	♀

			Women in R-DELLC (n=98)
Mean	1307	1293	1274
Median	1300	1280	1265
Standard Deviation	121.31	132.59	113.9
Minimum	890	910	990
Maximum	1600	1600	1590

*Missing cases = 127

Table 9 has means, medians and standard deviations for the combined SAT scores.

5.5 Engineering Retention

Retention in engineering was measured at two critical points towards degree completion. The first measure of retention was at the end of the first year (second semester). The second assessment of retention in engineering was at the end of the second year (fourth semester). Retention in engineering was defined as any engineering major in the School of Engineering at those two points in time. Student type, ethnicity/race, high school overall grade point average, and Scholastic Aptitude Test scores (verbal and math) were the control variables used to assess the outcomes of retention in engineering and college achievement. Multivariate analyses were conducted using multiple regressions for continuous outcome variables and binary logistic regression for dichotomous outcome variables (retention).

5.5.1 Retention Year One

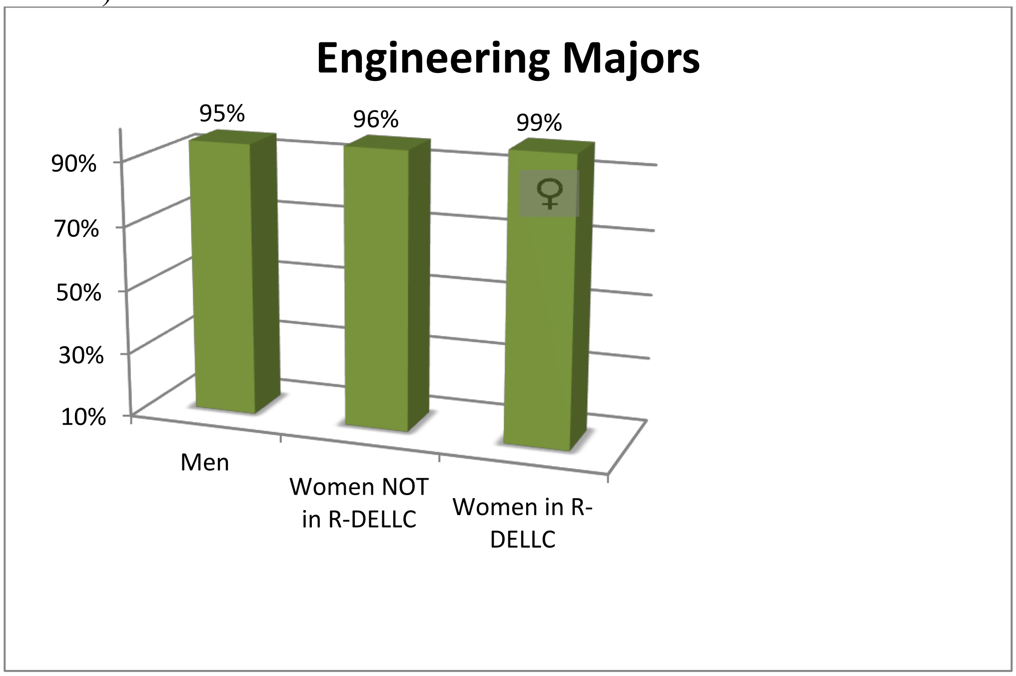
In the calculations, all engineering students admitted in Fall 2015 were systematically excluded from the analysis because the data files were downloaded just prior to the end of Spring 2016. Therefore, their student information for spring 2016 was not populated, yet. This only affected students admitted in 2015 as all other class years had completed information for their "year one." Table 10 shows that women in the Reilly Douglass Engineering Living-Learning community had a higher retention rate than all other first year engineering women and first year men, but this was not statistically significant (p=.310). Based on three full years of student retention (2012, 2013, 2014), by the end of year one for each cohort, the three cohorts of women in the Reilly-Douglass Engineering Living-Learning Community had a 99% retention rate as compared with 96% of all other women and 95% of men. It was interesting to note that the women in the Reilly-DELLC had the highest rate of retention (99%) in engineering as show in Table 10 and Figure 8.

Table 10. Retention in Engineering End of Year One
(N=2263*)

	Men		**Women NOT R-DELLC**		**♀ Women R-DELLC**		**Total**	
Engineering Retention Year 1	**N**	**% Within Student**	**N**	**% Within Student**	**N**	**% Within Student**	**N**	**% Within Student**
Retained	1619	95%	407	96%	72	99%	2098	96%
Not Retained	77	4%	15	4%	1	1%	93	4%
% of Total	1696	100%	422	100%	73	100%	2191	100%

Chi-Square: $\chi^2(2, N=2227)=2.343^{**}$, p = .310
*Missing Cases=36.
**1 cell had an expected count less than 5. The minimum expected count was 3.10
Note: 743 students who were admitted Fall 2015 were excluded because data were missing for Spring 2016 based on the date of data download.

Figure 8. Retention in Engineering at the End of Year One by Student Type
(N=2263*)



* Missing cases = 36.

A binary logistic regression was performed to examine adjusted differences in first year engineering retention. The control variables included in the regression were: gender (broken down by the type of student), race/ethnicity, and the achievement factors of HS GPA and SAT scores (math and verbal).

Table 7. Logistic Regression for Predicting Engineering Retention: Year One (N=2391*)

Variables in Equation	Odds Ratio	95% C.I. for Odds Ratio Exp (B)		p-value
		Lower	Upper	
Men	**1.00 (ref)**	**-**	**-**	**-**
Women Not in Reilly-DELLC	1.32	0.71	2.44	.383
Women in Reilly-DELLC ♀	3.10	0.42	22.92	.267
Race/Ethnicity:				
White	1.00 (ref)	-	-	-
Latino/a & Puerto Rican	1.79	0.72	4.44	.206
Black/African American	1.41	0.52	3.85	.504
Asian/Pacific Islander	1.07	0.67	1.71	.788
Overall High School GPA	**2.20**	**1.21**	**4.00**	**.009**
SAT: Verbal score	0.80	0.60	1.07	.135
SAT: Math score	**1.70**	**1.12**	**2.57**	**.012**
*Missing Cases = 164				

The binary logistic regression showed Reilly-DELLC community had three (3) times the odds of students staying in engineering at the end of the first year, but this was not statistically significant. The logistic regression did identify two significant factors that predicted the likelihood of a student remaining in engineering at the end of the first year of college: 1) the overall high school grade point average, and 2) scores on the SAT Math test. For every one whole point difference in HS Grade Point Average (e.g. a HS Grade Point Average of 3.0 to 4.0), a student was just over one time as likely to remain in engineering at the end of the first year of college (p=.009). Similarly, SAT Math scores were a significant predictor (p=.012) of the likelihood of students remaining in engineering at the end of the first year. For every 100 points difference in SAT Math score, there was a 70% likelihood of a student remaining in engineering in the first year.

While there was no significant effect of Verbal SAT scores for predicting retention in year one, it was interesting to note that there was a negative relationship between SAT Verbal and engineering retention. For every 100 points increase in SAT Verbal score, a student was 20% more likely to *leave* engineering. Also, it was interesting to note that, while not significant, a student in the Reilly-Douglass Engineering Living-Learning Community was just over two times as likely to stay in engineering as compared with women not in the community. There was also no statistically significant effect of race/ethnicity on first year retention in engineering.

5.5.2 Retention Year Two

Students identify the specific engineering department that they want to affiliate with (engineering major) at the end of their first year in college. So, at the start of the second year was when non-engineering majors emerged. While some students changed majors away from engineering, the majority of students remained in engineering. Overall, 88% of all men and women were retained in engineering in year two (Table 11). Table 11 Twelve percent of students had switched into non-engineering majors. Students admitted in the fall semester 2015 were excluded from the calculation because based on enrollment year they had not reached their second year. For students admitted in fall 2014, they were also excluded from the calculation because the spring 2016 data were not available at the time that the data were downloaded from the student record database. Students admitted in the fall 2012 and fall 2013 semesters did have completed records for year two and were included in the analysis.

Retention in an engineering major was evaluated and differences were seen between the engineering student groups (

Table 11). The women in the Reilly Douglass Engineering Living-Learning Community had the highest retention rate (100%) than those in the other student groups, whereas only 88% of men were retained and 89% of women not in Reilly-DELLC were retained in engineering.

Table 11. Retention in Engineering Year Two by Student Type
(N=1578*)

	Men		Women NOT R-DELLC		♀ Women R-DELLC		Total	
Engineering Retention Year 2	**N**	**% Within Student**	**N**	**% Within Student**	**N**	**% Within Student**	**N**	**% Within Student**
Retained	929	88%	230	89%	39	100%	1198	88%
Not Retained	128	12%	30	11%	0	0%	158	12%
% of Total	1057	100%	260	100%	39	100%	1356	100%
Chi-Square: $\chi^2(8, N=1284)=49.737^{**}$, p = .000 **Missing cases = 111 **1 cell had an expected count less than 5. The minimum expected count was 4.54								

Multivariate logistic regression was used to examine student group differences in second year retention (Table 12). The control factors included in the regression were: gender (broken down by student groups), race/ethnicity, and the achievement factors (high school grade point average and SAT math and verbal scores). Consistent with all other analyses conducted for year two, excluded from the calculations were students admitted in the fall 2015 because they had not reached their second year by spring 2016. Students admitted in fall 2014 were also excluded from the calculation because the data set had been download from the Rutgers systems just prior to the end of the Spring 2016 semester, before information was posted to student records. All other class years (2012,

2013) had complete information for two full years and therefore were included in the analysis. No results for year two engineering retention could be calculated because 100% of Reilly-DELLC students who remained in engineering at the end of year one persisted into year two. That resulted in an odds ratio that could not be validly estimated.

Table 12. Binary Logistic Regression Engineering Retention Year Two
(N=1467)

Variables in Equation	**Odds Ratio**	**95% C.I. for Odds Ratio Exp (B)**		**p-value**
		Lower	**Upper**	
Men	**1.00 (ref)**	**-**	**-**	**-**
Women Not in Reilly-DELLC	1.01	.63	1.62	.958
Women in Reilly-DELLC ♀	Could not be calculated because 100% of R-DELLC students were retained in year 2			
Race/Ethnicity:				
White	1.00 (ref)	-	-	-
Latino/a & Puerto Rican	**2.44**	**1.14**	**5.23**	**.022**
Black/African American	2.00	.86	4.67	.109
Asian/Pacific Islander	1.31	.89	1.92	.174
Overall High School GPA	**2.92**	**1.74**	**4.90**	**.000**
SAT: Verbal score	**.71****	**.56**	**.91**	**.003**
SAT: Math score	**2.00**	**1.40**	**2.80**	**.000**
**negative relationship				

Results of the logistic regression did show that HS GPA (p=.000) and SAT Math scores (p=.000) were significant predictors of the likelihood of retention in engineering in year two. For every whole point difference in high school grade point average (e.g. a Grade Point Average of 3.0 to 4.0), the odds of a student remaining in engineering at the end of the second year of college almost tripled. And, for every 100 points increase in SAT math score, the likelihood of a student being retained in engineering increased by 71%. It was interesting to note the negative relationship for SAT Verbal scores and retention in engineering. For every 100 point difference in SAT Verbal score, the odds of a student leaving engineering by their second year were significant and increased by 29% (p=.003).

Noteworthy is that women in the Reilly-Douglass Engineering Living-Learning Community entered college with the lowest mean combined SAT scores but the highest mean high school GPA. In both years one and two, the women in R-DELLC had the highest rate of retention and earned the highest engineering GPAs of the three groups. The predictors of retention would suggest that lower SAT scores would result in lower retention. However, given the high retention of women in the R-DELLC, it is plausible that due to the intervening supports provided though the community, retention was improved.

There was also a statistically significant result of race/ethnicity on engineering retention (p=.022). Latino/a students had 2.5 greater odds of being retained in engineering in the second year as compared to White students.

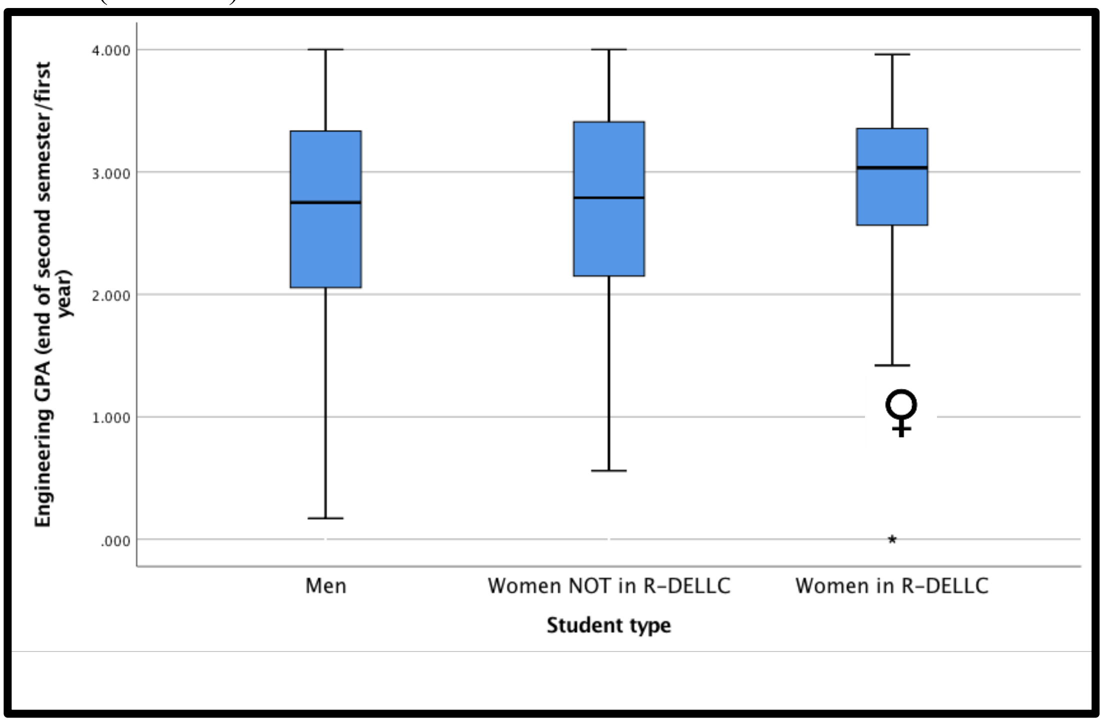
5.6 Achievement Outcomes (Grade Point Averages)

Academic achievement was measured via Grade Point Average (GPA) in the engineering major. The engineering GPA was a subset of the overall grade point average. Engineering GPA was calculated each semester for the first two years. The first two years included the first year and the sophomore year for students for which data were available (four semesters total, if available).

5.6.1 Achievement Year One

Year One grade point average was comprised of the Engineering GPA at the end of the fall semester (semester one) and the end of the spring semester (semester two). Consistent with the other measures of achievement and retention, for the first year engineering GPA, all students who were first admitted in fall 2015 were excluded from the analyses as they had not, yet, reached the end of their first year based on the date that all student records were download. Therefore, the analyses for Engineering GPA in Year One included all students admitted to the School of Engineering in fall 2012, 2013, and 2014 because their student records were complete.

Figure 9. Engineering GPA by Student Type, End of Year One
(N=2227*)



*Missing = 114

Figure 9 shows that at the end of the first year men had the lowest mean and median grade point average, and the largest spread of grades. Reilly-Douglass Engineering Living-Learning Community women had the highest mean grade point average (2.87) of the three groups, fewer low GPAs, and had the smallest spread of grades with an interquartile range of .84 and a median Grade Point Average of 3.04. The lowest GPA for women in the Reilly-Douglass Engineering Living-Learning Community was higher than the lowest engineering GPA in either of the comparison groups. None of the women in the Reilly-Douglass Engineering Living-Learning Community had a GPA below a 1.0 while the other two groups did have students with grades below a 1.0. Women not in the Community and men had median grade point averages that were similar to each other, although men had a wider range of grades. Table 13 shows means, medians and standard deviations of the first year engineering GPAs by student type.

Table 13. Distribution of Engineering GPA, End of First Year
(N=2227*)

	Student Type		
Engineering GPA End of First Year	**Men (n=1628)**	**Women NOT in R-DELLC (n=413)**	♀ **Women in R-DELLC (n=72)**
Mean	2.61	2.70	2.87
Median	2.75	2.79	3.03
Standard Deviation	.98	.91	.86
Minimum	0.00	0.00	0.00
Maximum	4.00	4.00	3.96

*Missing cases = 114
Note: all students admitted in fall 2015 were excluded from the calculation because the data were not populated in their student record at the time the data were downloaded. They do not appear as missing cases as they were filtered out before the calculation.

Multiple regression models revealed that high school GPA and SAT Math scores were important predictors of first year engineering GPA as seen in Table 14. For every one-unit increase in high school grade point average (e.g. 3.0 to 4.0), the college engineering grade point average in the first year was predicted to increase by one grade point (e.g. 3.00 to 4.0) (p=.000). Also predicting academic achievement in the first year was the SAT Math scores. For every 100 point increase in Math SAT score, a students' first year engineering GPA was predicted to increase by a little more than 0.40 points (e.g. 3.00 to 3.40) holding all other control variables constant (p=.000).

Linear multiple regression assessed student group differences in engineering GPA with adjustments for race/ethnicity, and high school achievement (HS GPA and SAT scores) on first year engineering GPA. While just outside of statistical significance (p=.057), students who identified as Asian/Pacific Islander demonstrated a slight difference in first year engineering GPA and race. As shown in Table 15, by the end of the second year (4^{th} semester), the difference between race and engineering GPA became statistically significant (p=.011) for Asian/Pacific Islander students. Holding all other control variables constant, the engineering GPA in the second semester, for students who identified as Asian/Pacific Islander, had a -0.081 lower GPA than white students (e.g. a grade of 3.00 would likely be a grade of 2.92). No statistically meaningful differences in first year GPA for other racial/ethnic groups were observed.

Table 14. Linear Regression Engineering GPA Year 1
(N=1990)

	Unstand. Coefficient	**Standard. Coefficient**	**t**	**p - value**	**95% Confidence Interval for B**	
	B	**Beta**			**Lower Bound**	**Upper Bound**
Constant	-3.859	-	-13.078	.000	-4.437	-3.280
Men (ref)	-	-	-	-	-	-
Women Not Reilly-DELLC	.017	.007	.334	.739	-.081	.114
Women in Reilly-DELLC ♀	.145	.027	1.356	.175	-.065	.355
Overall H.S. GPA	**1.010**	**.379**	**18.135**	**.000**	**.901**	**1.119**
SAT Math (unit conversion)	**.396**	**.258**	**11.024**	**.000**	**.326**	**.467**
SAT Verbal	-.008	-.007	-.319	.750	-0.057	0.041

(unit conversion)						
Race/Ethnicity						
White (ref)	-	-	-	-	-	-
Latino/a & Puerto Rican	.001	.000	.014	.989	-.141	.143
Black/ African American	-.031	-.007	-.337	.736	-.214	.151
Asian/ Pacific Islander	-.081	-.042	-1.908	.057	-.164	.002
Adjusted r^2=.23 ANOVA F test = 73.591 (p=.000)						

Overall high school grade point average had more weight than SAT math score in predicting college engineering grade point averages. Consistent with the finding of engineering retention in the first year, both SAT Math and high school GPA were associated with engineering GPA in the first year.

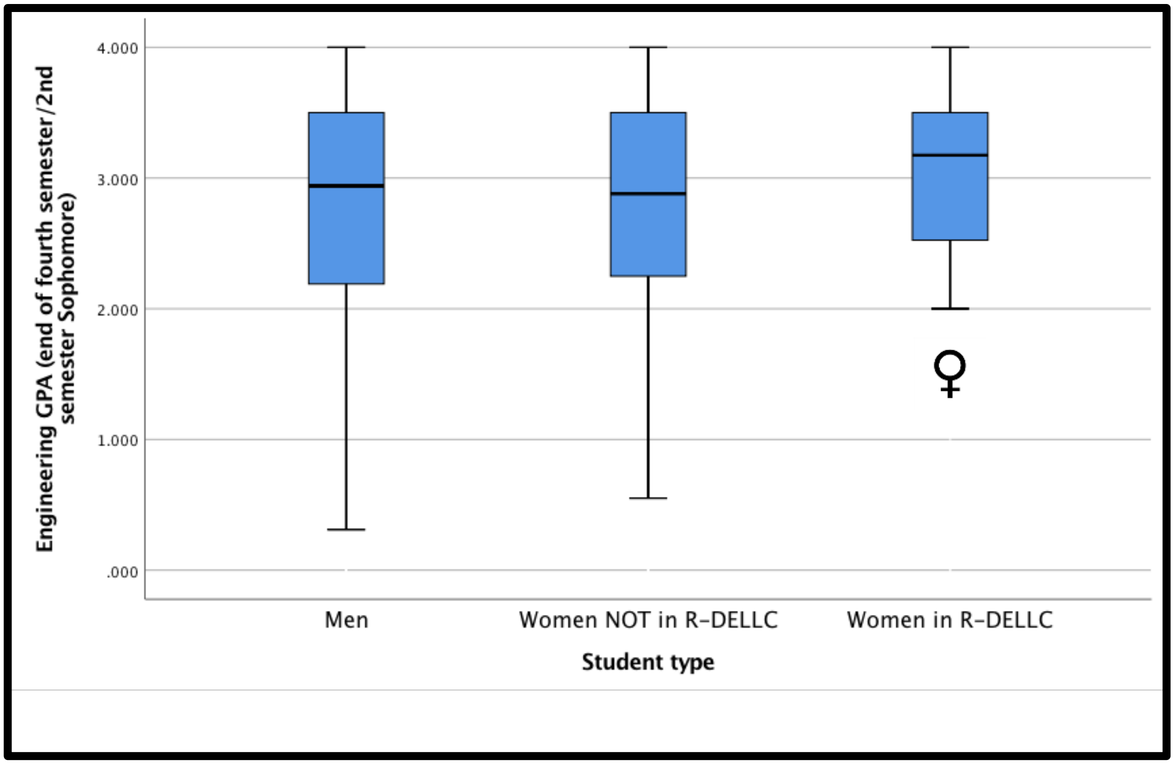
5.6.2 Achievement Year Two

Year Two Engineering GPA was comprised of the grades in the engineering courses at the end of the fall semester (semester three) and the end of the spring semester (semester four). Consistent with the other measures of achievement and retention, students who were first admitted in the fall 2015 were excluded from the analyses, as they had not, yet, entered their second year. Also, students who were admitted in fall 2014 were excluded from the second year statistical analyses because the data were downloaded prior to the end of the spring 2016 semester so that students admitted in fall 2014 did not have information populated for the end of their second year. Students admitted in fall 2012 and fall 2013 had completed records for their second years. Therefore, the analyses included all students admitted to the School of Engineering in fall 2012 and 2013. The excluded student records do not appear as missing cases because the records were filtered out prior to the calculations.

Figure 10 shows that women in the Reilly-Douglass Engineering Living-Learning Community had a higher median Engineering GPA at the end of the second year (3.17) as compared with women not in the Community (median GPA = 2.88) and when compared with men (median GPA=2.94). The mean GPA of the women in the Community was also higher than the two comparison groups. Women in the R-DELLC also had the smallest range of GPAs with a higher median GPA (3.17) than the comparison groups. Little variation between men and women who were not in R-DELLC was observed. The interquartile range for women in the Reilly-Douglass Engineering Living-Learning Community was 0.99, which was a smaller range than the comparison groups. On average, the median for men and for women not in the Reilly-Douglass Engineering Living-Learning Community was similar as was the range of grade point averages for these two student types.

Table 15 provides means, medians and standard deviations of second year GPA.

Figure 10. Engineering Year Two GPA by Student Type
(N=1,467*)



*Missing cases = 442

Table 15. Distribution of Engineering GPA, Year Two by Student Type
(N=1,467*)

	Student Type		
Engineering GPA End of Second Year	**Men (n=727)**	**Women NOT in R-DELLC (n=192)**	**♀ Women in R-DELLC (n=36)**
Mean	2.73	2.78	2.91
Median	2.94	2.88	3.17
Standard Deviation	1.00	.96	.95
Minimum	0.00	0.00	0.00
Maximum	4.00	4.00	4.00

*Missing cases = 442

Linear multiple regression was used to assess student group differences in second year engineering GPA with adjustment for race/ethnicity, and high school achievement on second year engineering GPA (Error! Not a valid bookmark self-reference.). No statistically meaningful differences in second year engineering GPA were seen based on the student group. Consistent with prior models that included high school achievement, in the second year, the overall high school grade point average and SAT math scores were significant predictors of second year engineering GPA. For every one-unit increase in overall high school grade point average (e.g. 3.0 to 4.0), the college engineering grade point average was predicted to have a difference of .89 points (e.g. 3.00 to 3.89) (p=.000). For every 100 point increase in SAT Math score, engineering grade point average in the second year was predicted to increase by nearly .4 points (e.g. 3.00 to 3.40) adjusting for all other variables (p=.000). The SAT verbal score emerged as a significant factor in the second year. For every 100-point increase in Scholastic Aptitude Test Verbal score, engineering grade point average in the second year was likely to be lower by approximately .12 of a point (e.g. 3.50 to 3.38) adjusting for all other variables (p=.003).

Table 16. Linear Regression Engineering GPA Year 2, All Control Variables (N=970)

	Unstand. Coefficient	Standard. Coefficient	t	p - value	95% Confidence Interval for B	
	B	Beta			Lower Bound	Upper Bound
Constant	-2.467	-	-5.286	.000	-3.383	-1.551
Men (ref)	1.00	-	-	-	-	-
Women Not Reilly-DELLC	.010	.004	.124	.901	-.146	.165
Women in Reilly-DELLC	.075	.013	.448	.654	-.255	.405
Overall H.S. GPA	**.890**	**.308**	**9.879**	**.000**	**.713**	**1.067**
SAT: Math score (unit)	**.392**	**.243**	**6.899**	**.000**	**.281**	**.504**
SAT: Verbal score (unit)	**-.125**	**-.099**	**-3.005**	**.003**	**-.207**	**-.043**
Race/Ethnicity						
White (ref)	1.00	-	-	-	-	-
Latino/a & Puerto Rican	-.183	-.055	-1.702	.089	-.393	.028
Black/ African American	-.266	-.051	-1.608	.108	-.501	.050
Asian/ Pacific Islander	**-.170**	**-.085**	**-2.554**	**.011**	**-.301**	**-.039**

Adjusted r^2=.16
ANOVA F test = 24.331
(p=.000)

By the end of the second year of engineering, a significant (p=.011) difference between second year engineering GPA and race emerged for students who identified as Asian/Pacific Islander. Holding all other control variables constant, the second year engineering GPA, students who identified as Asian/Pacific Islander would be likely to have a -0.17 lower GPA than white students (e.g. a GPA of 3.00 would likely be a GPA of 2.83).

5.6.3 Intended Engineering Major

The four majors in which women predominated were Biomedical, Bio-environmental, and Biochemical/Chemical. This may suggest women may be more interested in pursuing engineering majors that involve the "bio" component in the curriculum. The most popular intended engineering majors for women was Biomedical Engineering. One possibility was that Biomedical Engineering appeared to be the engineering discipline that most directly related to professions in medicine. And, nationwide, there were more women in life sciences majors than men, further reinforcing women's interest in the medical professions (National Science Foundation, 2017; National Student Clearinghouse Research Center, 2015; Thoman, Arizaga, Smith, Story, & Soncuya, 2014). Therefore, the trend for women to pursue medicine and medical-related professions in disciplines *other* than the traditional sciences fits with finding that more women intended to pursue the engineering area that most directly related to medical professions.

Data collected through qualitative research corroborated the finding regarding a higher interest by women in engineering that had a 'bio' focus. The interviews provided insights as to why women were more interested in Biomedical Engineering than all other engineering majors. During the interviews, one of the participants revealed that her parents did not support her intention to pursue engineering. It was not viewed as an acceptable profession for a woman in her culture. However, because the focus was Biomedical, her parents viewed it more favorably and they agreed to allow her to enroll.

Another student stated that her goal was to attend medical school and viewed this major as a way to achieve that dream. She also indicated that Biomedical Engineering enabled her to use her passion for math and science, rather than follow a traditional sciences-only route. She was a senior when interviewed and she had already been accepted to medical school.

5.6.4 Ethnicity/Race

While there was no direct explanation of why Latina/o students were two times as likely to remain in engineering as White students, it was noted that the Latina women that I interviewed (see Chapter 6, Qualitative Results) were the first in their family to go to college or the first in their family to be an engineer. Further, some participated in additional support programs for minority students in engineering. Examples of support programs included, student chapters of the Society of Women Engineers (SWE), the Society for Hispanic Engineering Professionals (SHEP), and/or the Minority Engineering Educational Task (MEET), a chapter of the National Society of Black Engineers. Students reported that they belonged to more than one student group in addition to Douglass. These additional networks, connections, and resources may have contributed to a higher likelihood of retention in engineering. Some of the participants spoke of the sacrifices their parents had made in order to ensure a better quality of life for them, so they intended to persist in engineering.

5.7 Summary of Impacts

Three research questions focused on outcomes of participating in the women-only living-learning community as compared with men and with women who did not enroll in the community. The first question considered the effects of the women-only living-learning community on the recruitment of women into engineering at Rutgers. The second question looked at the retention of women who participated in the R-DELLC as compared with men and as compared with women who were not in the LLC. The third of the four research questions examined the academic outcomes of students in the Reilly-Douglass Engineering Living-Learning Community in comparison to the two other student groups. The findings of this study indicated significant outcomes for all three of these questions. The summaries of findings are discussed below, related to each research question.

5.7.1 Recruitment Outcomes

The first research question explored if a women's-only living-learning community affected the recruitment of women in engineering. An analysis of the data revealed a 24% increase in women in engineering in the Rutgers School of Engineering from the inception of the LLC (2012) through the fall 2015 semester. Given the low numbers of women, enrolled in engineering, world-wide, a 24% increase of women in engineering within a four year time period at Rutgers can potentially be important for the recruitment of more women into engineering.

Living-learning communities offer access to people, information, resources, support, and opportunities. Causality cannot be determined by this study; however, the findings suggested that the significant increase of women in undergraduate engineering during the study time period, may be due, in part, to the availability of a women-only living-learning community in engineering. The interviews included in the qualitative data chapter (Chapter 6) triangulated the findings of the quantitative research, which is that students chose Rutgers University due to the availability of the women-only engineering living-learning community. Participants spoke about what they anticipated would be gained by being surrounded by other women engineering students.

Corresponding to the significant increased proportion of women enrolled in the Rutgers School of Engineering between the years 2012 to 2015, the Reilly Douglass Engineering Living-Learning Community was able to expand to accommodate more students. Enrollment in the Reilly-Douglass Engineering Living-Learning Community, itself, increased 65% from year one to year four. In the inaugural year of Reilly-Douglass Engineering Living-Learning Community, there were 20 women enrolled in the community. By the fourth year (fall 2015), there were 33 women in the community, which was the capacity of the community. This increase in the community contributed to the overall increase of women in engineering at Rutgers.

5.7.2 Retention Impact

The second research question was whether the availability of an engineering women-only living-learning community affected the retention of women in engineering. An analysis of the all data revealed that the availability of the women-only community did positively affect the retention of women in engineering. Women in the community were retained at higher rates than the comparison groups (men and women who were not in the LLC).

In the inaugural year (2012) of the R-DELLC, there were 20 students enrolled in the community. At the end of that academic year (spring 2013), 18 of the 20 students were retained in engineering. Regarding the two students who left the community, one student dropped out of college and one student changed majors away from STEM. The 18 women who were retained at the end of the first year (Spring 2013) were also retained in engineering four years later (Spring 2016). All 18 Reilly-DELLC women from the inaugural class were seniors and were a few days away from graduating with a Bachelor’s in engineering when I met with them for individual interviews. Factors affecting retention are more fully discussed in the analysis of the qualitative data (Chapter 6). Some of the women indicated that they had plans for graduate school, while other students were entering the workforce, as engineers or in a related area.

It was also expected that all of the rising seniors (class that entered in 2013) in the Reilly-Douglass Engineering Living-Learning Community would also be graduating with a degree in engineering. This was expected because 100% of the students who entered in 2013 and completed their first year were still retained at the end of their junior year and all had an engineering major. The significance of the higher retention rate for women in the Reilly-Douglass Engineering Living-Learning Community supports the research question of whether the women-only community affected engineering retention.

Communities of support may be a way to help undergraduate women students remain in engineering since academic achievement, alone, can not explain why women leave engineering at higher rate than men (Galdi, Cadinu, & Tomasetto, 2014). Core relationships that were developed within a community became critical because stronger ties between community members were created. These stronger (core) relationships then provide support (including emotional support), influence behaviors, and provide advice to its members (Moore et al., 2011).

As detailed in the qualitative data analysis (Chapter 6), the students in the Reilly-Douglass Learning-Living Community had formed a group identity as, "the Douglass girls." Participants frequently spoke about the strong feelings that they had each other (in the community) and how those relationships helped them to get through academics and personal difficulties, which "kept them going." The mutual respect and support was an important factor because the students encouraged each other and regularly reminded each other that they would not let anyone in the community fail and that they were in it "together."

In addition to the friendships that developed in the Reilly-DELLC, the participants also spoke about the emotional support and different forms of assistance that community members offered to each other. Many of the participants indicated that they would not have succeeded "without those girls." Evidence of the attachments and core relationships developed through participation in the living-learning community is more fully detailed in the qualitative data analysis chapter (Chapter 6).

5.7.3 Academic Outcomes

How did the undergraduate women in the Reilly-Douglass Engineering living-learning community (R-DELLC) compare academically with men and with undergraduate women in engineering at RU-NB who were not in that community? This research question was answered with a comparative analysis of the engineering grade point averages of the three groups of students in this study. In sum, women in the Reilly-Douglass Engineering LLC, on average, entered college with lower SAT scores (math and verbal) than the comparison groups. However, by the end of the second year the women in the R-DELLC had the highest mean and median engineering GPAs and the highest retention rates when compared with men in engineering and women who were not in the R-DELLC.

Causality of the higher GPAs for women in the community cannot be attributed to any particular factor or by participation in the R-DELLC. However, it was a powerful finding. The data collected through interviews (and discussed in Chapter 6) indicated that supports provided within and for the R-DELLC offered the emotional and academic supports, which students recognized as helpful in their academic achievement. This validated the findings of how the women-only LLC impacted student academic achievement, retention, and recruitment of women.

CHAPTER 6: QUALITATIVE DATA ANALYSIS

6.1 Introduction

In addition to the quantitative data collected for this study, this program evaluation also considered factors affecting the persistence of women in engineering from the first year through the fourth year from the perspective of the student participants. This evaluation aimed to understand the impact of the women-only living-learning community on experiences of the participants. In addition, the effects of the community on the recruitment and retention of undergraduate women in engineering was explored.

By understanding the experiences of the women enrolled in the Reilly-Douglass Engineering Living-Learning Community, it may be possible to consider if the model of the living-learning community, as developed and implemented at Douglass Residential College, can be a viable intervention to positively affect women's persistence in engineering. The implied question is whether this model of a living-learning community for women in STEM can be utilized for other majors in which women are underrepresented and the possibly of replicating the model at other institutions.

6.2 Data Collection

In planning and executing this study, the guidelines of the Rutgers University Institutional Review Board (IRB) were strictly followed. Qualitative data were collected through semi-structured individual interviews. The interviews were conducted at different locations convenient to the participants. The majority of interviews were conducted in the office space on the Douglass Campus at Rutgers-New Brunswick. However, some interviews were held in public libraries of the town where participants resided. Others were completed at the libraries on the Newark and New Brunswick campuses. All of the interviews were conducted using hand-held digital recording device.

All interviews and recordings were done after the explicit written permission of each participant. All interviewees were provided with a copy of their signed consent form. Interviews lasted between 50-120 minutes. The researcher conducted all the interviews and transcriptions of the recorded responses of participants.. Interview questions were modeled after the questions used for the Academic Pathways Study (APS), once permission was obtained[1] from Center for Advancement of Engineering Education (CAEE).

6.3 Analysis of Student Interview Data

Nvivo software was used to code and analyze the transcribed interviews for emergent themes. To ensure confidentiality, participants' names were not used in recording and transcribing the interview data as well as in reporting the results. Interview data were transcribed verbatim and direct quotes from participants were included in the analysis. This approach aimed to capture participants' own thoughts and experiences of the women related to the Reilly-Douglass Engineering Living Learning Community.

Through an ongoing process of coding and analyzing the qualitative data, several main themes emerged: 1) a positive expectation of benefitting from a network of immediate friends and women who would be going through the same experiences; 2) the

---

[1] Used with permission: Sheppard, Atman, Fleming, Miller, Smith, Stevens, Streveler, Clark, Loucks-Jaret, & Lund, 2010, pp. 3C 26-32.

role of the living-learning community in creating a supportive social environment for women; 3) a distinct identity as a "DELLC woman" developed as a result of belonging to the community and which was embraced and valued by the participants; 4) the role of the living-learning community in creating an academic space that promoted women's success in engineering courses; 5) the role of the living-learning community in creating a social network with strong connections to each other, faculty, and to resources; and, 6) gender discrimination and alienation from male students and some male professors that was experienced by women students in- and outside- of the classroom.

6.4 Participant Demographics

Individual interviews were conducted, in English, with 21 women enrolled in the Reilly-DELLC. Five students from each cohort (years 2012 through 2015) were selected. Students were invited to participate in this study via email. The Institutional Review Board (IRB) at Rutgers University had approved the invitation email. See Appendix A for the approved invitation letter. The selection was based on the year of enrollment and race/ethnicity to ensure diversity in the sample.

6.4.1 Race/Ethnicity

Race/Ethnicity was self-identified by the women in the Reilly-Douglass Engineering Living-Learning Community both during the interview and upon initial admission to college. It was noted that there was consistency between the self-report during the individual interview and the race-ethnicity coded on each admissions application. In total, there were 21 women interviewed comprised of white (7), Asian/Pacific Islander (10), Black/African American (2) and Hispanic/Latina (1).

In comparison to the overall population of engineering students enrolled during the same time period, both the Reilly-Douglass Engineering Living-Learning Community and Rutgers School of Engineering reported that the majority of students in engineering self-identified as Asian/Pacific Islander. Similarly, the second largest representation of all engineering students and those in the Reilly-Douglass Engineering Living-Learning Community were White. This accounted for the vast majority (86%) of all engineering students enrolled from fall 2012 through fall 2015.

The Reilly-Douglass Engineering Living-Learning Community proportionately enrolled almost twice as many students who identified Black/African American as compared with all students in the School of Engineering. Differences were also noted for students who identified as Latina and Puerto Rican. Only six percent (6%) of women in the Reilly-Douglass Engineering Living-Learning Community identified as Latina and only one percent (1%) self-identified as Puerto Rican, both of which were fewer when compared with all other students in engineering at Rutgers during the same time period. graphically depicts the racial/ethnic comparison by percentage.

6.5 Year of Entry

All students interviewed were first year students in the year that they entered. No transfer students were admitted into the Reilly-Douglass Living-Learning Community. Therefore, in the complete sample, student ages ranged from 17 to 18 years old upon entry into the community to 21 to 22 years old at the end of their fourth year.

All participants who were retained in engineering after their first year had entered in September 2012 and finished the engineering program in four years, graduating in May

2016. They were the inaugural graduating class for the women-only living learning community. It was noted that a review of the transcript for the students who were in their Junior year at the time of data collection/interviews (had entered in September 2013) were 'on track' to graduate from the School of Engineering at Rutgers-New Brunswick in four years (May 2017).

6.6 Type of High School

The majority of women in R-DELLC (81%) had attended and graduated from a regular public high school. Five percent of the women in R-DELLC had graduated from a specialized technical high school (public). The remaining 14% of the R-DELLC students had graduated from a religious school, private high school (not religious), or an international high school. Three of the students were international student (non-resident of the United States): two Asian/Pacific Islander students and one Black woman from an African country.

6.7 Interest in Engineering

6.7.1 Motivation to be an Engineer

The women who belonged to the engineering living-learning community and agreed to participate in the individual interviews revealed information how they first became interested in engineering, why they wanted to study engineering in college, and related questions about their motivation for the engineering degree and profession. The top four reasons that the women were interested in studying engineering in college were: 1) being good in math or science; 2) having had extra-curricular experiences in math- or science-related activities in elementary school, middle school, or high school; 3) having a family member or close family friend who was an engineer or 4) encouragement by a high school teacher particularly a science, math, or technology teacher.

Many of the students reported that they became interested in engineering either through programs that provided hands-on experiences and engineering projects. For the participants who were involved in extracurricular activities that were math-oriented or science-based, the majority of these activities involved projects or building something, not just solving problems on paper. Some were programs targeted to middle school in engineering. Others were co-educational programs that offered classes in math or sciences and connected the information to how the academics relate to what engineers do. A few students reported that they always liked building things and solving puzzles. Some students were inspired to pursue engineering because they liked to take things apart to find out how things worked or to fix things that were broken.

Table 17. Motivation for Engineering Major, Rutgers, and Douglass LLC

Motivation for Engineering	Count and Percentage of Student Replies (total n=21)*	
	N	Percent
1. "Good" in math and/or science	21	100
2. Experiences: Sciences, math, engineering	19	91
3. Family member or family friend an engineer or studying engineering	10=immediate family 5=extended	72
4. Encouragement of high school teacher	**12**	**57**
Motivation for Rutgers University	Number and Percentage of Student Replies (total n=21)	
1. Reputation of the University	**16**	**76**
2. Financial support or tuition cost	**10**	**48**
3. Influenced by family, friends, teachers	**10**	**48**
Motivation for Douglass Engineering Community	Number and Percentage of Student Replies (total n=21)	
1. Expected support, community, friends	**21**	**100**
2. Resources and opportunities	**12**	**57**
3. Encouragement of friends or family	**10**	**48**

*n=21 participants (20 retained / 1 who left engineering in the first year). Percent calculated based on the total n=21

6.7.2 Perceived Skill in Math or Science

All participants stated that they were motivated to study engineering in college because they were good at math, good in science, or did well in both disciplines. They also indicated that they had "always liked" math, science, or both subjects. Their interest in math and science helped narrow down their choice for a major.

> My brother is Mechanical Engineering and my father is Chemical Engineering. My mom and sister are teachers. So, the two women in my

family are teachers and the two men in my family are engineers. When you're talking about genders, it's kind of, oh my mom and sister are teachers but my dad and brother are engineers. I liked to bake and cook. My mom brought out a point where you can be an engineer and cook and bake on the side but you can't be a chef and be an engineer on the side. So, it was a pretty strong point for me to be an engineer. I knew I was way too nerdy and I found out things really fascinate me and I was way too curious. The more I thought things out in terms of the long term, I thought being an Engineer would be pretty cool. (Annie C.)

I learned about biology and I was really always good at biology. I watched the discovery channel, all the science channels. So doing biology made me realize that I wanted to study the human body and I really liked the brain. I like the psychology part but I like the physiology part of the brain more. So, I really like working with people, I like helping people in science and then I connected it and thought about biomedical engineering. (Cindy N.)

I set my parents down - this was during the college application process. I said, "Mom, dad, I love math and science, I would love to go in engineering." Engineering encompasses both math and sciences, so I thought it would be perfect. Then I picked engineering and I got the "yes" from my dad, first. He was jumping with joy; and my mom was, "okay." (Penny M .)

> Everything is based on math and even my science classes are physics-based. That focus hasn't really changed, it's just more time to go into it. (Diana S.)

> I started looking to some other aspects that still were based on architecture and the building idea, and I came across engineering. Because I liked math, I was like, "okay this might work out." (Valerie K.)

Some students indicated that subjects that did not produce one clear answer, such as English class with written essays, were not their preference. Because they considered themselves to be very analytical in their thought process, they preferred to engage in learning or working where a consistent outcome or a “right” answer could be produced. Writing essays to answer a question was perceived as too ambiguous and grading is based on the judgment of the reader.

> I knew that I didn't want to do something biology-related, and I wasn't crazy about the idea of anything English because I wasn't comfortable with the fact that there kind of wasn't a right answer; that you just judged on your work based on how other people feel and other people's experiences. So, I dislike that aspect a lot. And, English didn't give me trouble, but I was always catering to the teacher every single year, so I didn't really feel like I had my voice or anything like that. And with essays, I felt the most comfortable writing with once there was a template. Because like I do all that, if there's a formula to it, I could do it. (Jayne W.)

6.7.3 Enrichment Programs

The second most frequently cited reason given for the motivation to pursue engineering was because of extra-curricular programs that directly exposed the women to engineering or related areas. Nineteen out of the twenty-one students (91%) reported that they had been able to participate in science, math, or pre-engineering enrichment programs, some of which were exclusively for girls. Some of the students had engaged in the pre-engineering, math, or science programs while in elementary school. Other students had their first exposure in middle or high school.

The participants recognized that the extra-curricular experiences in pre-engineering programs, math, or science activities had exposed them to problem solving and critical thinking. Nineteen participants reported that these programs provided hands-on experiences with building activities and projects. These experiences as children or teenagers helped develop their passion for the sciences and math - and subsequently had drawn them towards engineering as a profession.

> I was in high school and I was part of JETS. It was the Junior Engineering and Technology Society but with that we had to visit companies and I just saw what they did. I was like, "okay." I felt like I wanted to do science, but with me, I don't think I gave much thought to deciding because I just wanted something that had the science and the math. So, Engineering was one of the only things that had both together and in the proportion I wanted. (Olivia S.).

> I remember when I was younger, there was a solar car race that I became a leader of with my little team, and we were able to build solar cars from wood. They

gave us a certain amount of weight and dimensions that we had to make it. Our team ended up winning for... I think it was the best design. (Judy F.)

I didn't know it was engineering at the time, but I was always interested in building things since I was really young. I always wanted to be a carpenter but mom said, “no, be an architect,” and dad said, “no, carpenter.” But, then I was in 5th grade and I was in this special program and it was all about hands-on things. So we did a lot of projects. My freshman year of college we did what I had already done as a kid in elementary school in that program and they were all to get you thinking kind of like an Engineer. I just didn't know that at the time. They had other things, too, that were focused on like history and other aspects of life but what always stuck out to me was the Science and Math project-based things and at the end of it you seem to kind of have like a thesis type of thing that we had to do. So, they told us to make a project about something; and so I remember I met my best friend in that class and we decided we were going to do something about the environment and so we did like 5 different kinds of projects like a puppet show, diorama, and a bunch of other things mainly focusing on environmental problems and fixing them and adjusting them. It kind of made it my mission to help the environment. Then as I went through school I've been really good at math and science and it was no longer about being a carpenter but it was engineering. (Sadie B.)

My favorite teacher ever in high school was a computer engineer. And that just made me honestly want to program more. She gave me a referral to a program for engineering but I really didn't want to go, I didn't even know what engineering was. I thought it was just something the boys used to do with Legos. And I guess my guidance counselor she kind of gave me the boot; like, called my mom and said I had to go. So I went to the program hosted by the Minority Engineering Educational Task. Basically an engineering group that helps minorities in every aspect and that's what really opened me up to engineering and made me like engineering. I didn't want to sit here and build things all day but when they said computer engineering I felt enlightened and I looked more into what computer engineering was about. When I went to look at the curriculum, I loved this program so much. So my last choice (of majors) actually became my top choice. (Tina K.)

I was always interested in building things, so I would always play with Legos and Connex, and those sort of hands-on type toys. In middle school, I was interested in architecture because it's very visual but it's also based on geometry. I started looking into and I came across engineering. Because I liked math, I was like, okay this might work out. Then I started looking to the various kinds in engineering and I volunteered at the municipal engineering department in my town, and that showed me how Civil Engineering work, I realized that's not exactly what I like. At that time I was taking AP chemistry, and I realized I really loved chemistry. It was very interesting and very detailed and very mysterious to me, so I decided upon Chemical Engineering because it combined both math and chemistry. (Vivian K.)

6.7.4 Influence by Family and Teachers

While skill in math and the sciences are a good foundation for engineers, the interest in those subjects typically did not stand alone as the sole reason for selecting an engineering major. An important factor that was coupled with the math/science skill and interest was the encouragement of someone they trusted and had an established relationship with them. That person was either someone in the family or a high school math or science teacher.

Fifteen students (72%) had someone in their immediate family or a close family friend who was an engineer or was employed in the math or science profession. Ten students of these students (67%) reported someone in their family was an engineer or an older sibling currently studying engineering in college. Five students (33%) indicated that someone in their family was in a field that was closely related to engineering, such as math or science.

The presence of an engineer in their lives was considered influential. They spoke about having grown up knowing what engineers do with easy access to someone they could ask questions of about the profession. Their family member(s) often encouraged them to get involved in building things and actively engaged them in activities such as helping to build something or repair broken machinery. The students indicated that they were comfortable choosing engineering as a major and expected the level of difficulty of the coursework before entering college.

My father used to work as a mechanic. So, I watched him fix washing machines or just broken things at home and that fascinated me, a lot… I believe it was being with my father because we girls weren't allowed to do really much in our culture. You're not allowed to exit the house or just things like that. But being at home, where I watched my father do a lot of those things and I would help him with those things, that I think definitely got me interested in engineering. And I like the feeling of touching these tools, I like the feeling of being able to fix something. I knew politically in this world, there were a lot of things that needed to be fixed. And I know something that I, at the time, didn't know that I had power to do that but I mean if there is something broken in front of me, it had the potential to be fixed, that was something that I could possibly fix. So, I think that was one of the main experiences that really led me to knowing what I want to do (Randy S.)

My brother is in Mechanical Engineering; he is older. My father is a Chemical Engineering. There are other engineers in my family, too. Two of my other aunts are engineers: a civil engineer and a biomedical engineer. So I was kind of already familiar with it. (Annie C.)

My uncle was an electrical engineer. My uncle had tried to get all of his kids to be engineer, and none of them ended up becoming engineers. But my uncle was very smart. I think the more we talked about engineering, the more I thought it was really exciting, and the more I kept scheduling dates with my uncle so that we could go for sushi and just talk about engineering. He got me excited about it because nobody had mentioned it to me in high school; nobody said a word about it in high school. (Jayne W.)

My brother is in Aerospace I was in middle school when he went to college for engineering. So in middle school, I started looking into engineering things. From the eighth grade until I started college, every summer I went to a program for girls who were interested in engineering and technology. The more I looked into it, the more fitted engineering seemed to my interested. I really like the way my dad talked about it, it's like problem solving, you use your skills to solve a problem that helps other people or improve something, so I really like that. My brother was doing cool things like research, he worked at NASA, and I was like, This is really cool. So I saw a lot of opportunity that's why I went into it. (Diana S.)

I was interested in engineering definitely by my father because he's a mechanical engineer, and he got his degree based off of his father who was engineer because he worked in engine rooms, like with ships. Ever since I was younger, he was a really big influence for me and for my sister because we were really tiny and he would say, "Oh look, an engineer made that, and an engineer made that." So it was always a key word growing up. Then I was thinking, "I want to do that because you're telling me that's a good major you can have a great career." I guess just watching other family members also getting engineering degrees was also something that sparked my interest in engineering. (Judy F.)

6.7.5 Encouragement by a Teacher

High school teachers were noted by 12 students (57%) as someone who significantly influenced them and provided important support in considering engineering as a major in college. These students stated that a high school teacher inspired them or took the time to make the connections between their skill or passion for math or science and how engineering could be a good fit.

> Definitely, my high school teacher; he was my chemistry teacher and he was also my sports coach. He saw the potential in me; constantly pushing me. And he would look at me every day. He said, “You know, you’re going to be an engineer.” And that definitely helped me. And even now, even though I am in college, doing things that I want to do, whether I want to fly or travel or do any sorts of things, he’s always there to push me. Yeah. He always motivates me. I think that he was very important person to have in my life. (Randy S.)

> I actually decided to go in engineering because of my physics teacher. He was great. (Penny M.)

> Then after having really good relationships with my high school science teachers and math teachers, I found that that's something I could do well with, and you can create anything with engineering, so I really saw that as a worthwhile major for myself. (Judy F.)

6.7.6 Did They Feel Prepared?

The students, in general, expressed the perception of being prepared for the rigors of engineering and for the demands of college, in different ways. Some women spoke of feeling prepared upon entering their first year based on the strength of their high school math and science courses or whether their high school teachers were "good" or not in teaching them the material. Most often "feeling prepared" for engineering centered on the students' own perceived knowledge of math and the sciences.

While most participants thought they came into college prepared for the rigors of engineering, they found out that they were not ready for the high volume of work or the level of difficulty. Most of them had never lived away from home hence preparation for college also required them to learn to be independent in and out of the classroom. Learning to ask for help from professors and peers was another challenge of college life..

In high school, when they tried hard, they achieved good results (good grades). However, in college, trying hard and studying is not enough as the material is difficult to understand. Hard work in college often resulted in low grades, which they found discouraging as they were not used to putting in effort and getting low grades. They were honors students in high school but received low grades or failing after much effort in college. The women questioned their own abilities and considered whether engineering was the right major for them. Some felt that everyone else understood the material and wondered, "what is wrong with me" or "it's just a matter of time before everyone figures out that I don't know what I'm doing."

> In engineering if I fail a course, it doesn't mean I don't know it, it's just that the professor changes from professor to professor but I wish that they would like tell

me that, “it’s ok, like GPA it doesn’t matter.” You could still do well in the lab and you could do something cutting edge and make impacts. That’s [the grade is] just such a small part of the story…So one of my friends is not in engineering and she is putting in the effort but at least she’s getting the results back. In engineering we put in the effort and we get the worst results back. And, we’re like banging our heads to the wall and I don’t understand…I’ve put in the effort so many times for courses and it’s like, “why am I still not doing well?” (Cindy N.)

I think the student I am now is not someone I thought I would've been, but I think that's not entirely a bad thing. I know I'm not excelling to be honest because like I always thought I would have been, but I guess I learned a lot through the process. I'm now able to evaluate what I do better and realize okay, so this is what you made a mistake in, like you should've done this more, I should've done this better vs. in high school I kind of never understand what it was like to not do well because of things were easier to do and teachers were not as difficult. (Mary A.)

I honestly thought I was a lot more prepared coming in than I feel I turned out to be. I don't think high school prepared me for what college has to offer. Because in high school, the smaller the class, teachers are nice and give more leeway. They say things like, “just take a day off today” or “I'm just going to postpone this quiz.” Or, they give out extra credit for whatever. And college doesn't have that to offer. A lot of times you have to teach yourself everything in college and [professor’s] office hours don't correlate with your time, so you basically feel as if

> you're doing everything on your own. And that was a major difficulty for me (Mary F.)

> Because in college even though I'm 45 minutes away from my home, my parents aren't here every single day to watch me and give me advice for certain things. So, it's a lot of learning on your own and becoming an independent person, whereas, in high school it was different. In high school, you go home every day and you see your family. Unlike here, you go home, you see your roommate, and sometimes you have issues with your roommate, and you have to figure out how to deal with those challenges away from home… Just having a good balance of social life, health, as well as academics. For me that was the hardest thing just because I am one of those people that likes to be part of everything [chuckle]. (Judy F.)

> So from high school I thought I was prepared, but the professors were going fast and I struggled keeping up and trying to balance everything. And it was hard to reach out to the professors because you didn't want to like go up and feel like you don't know anything. (Harriet D.)

6.8 Why Rutgers and Douglass Residential College

6.8.1 Selecting Rutgers University – New Brunswick School of Engineering

Once the participants had determined that they intended to study engineering, they had to select where they would complete their undergraduate education. When asked why they chose the School of Engineering, Rutgers University-New Brunswick, the top four reasons were: the reputation, opportunities or size of the school; the cost or scholarships offered, and the positive influence of family or friends. Financial reasons and the influence of family or friends were the top two reasons for choosing Rutgers.

Sixteen students (76%) indicated that the reason they chose the School of Engineering in Rutgers University-New Brunswick was due to the school or university's reputation, the opportunities offered to students, and/or the size of the school, and its proximity either to their home or to major cities such as Philadelphia and New York. In addition to the reputation of Rutgers University – New Brunswick, two students indicated that they Rutgers *specifically* because of the engineering living-learning community offered through Douglass Residential College and the School of Engineering at Rutgers University – New Brunswick.

> I found everything that I wanted here and even more. Giving advice to my brother right now, he thinks it's a big school because he's very a shy kid like I was, too. I'm like, "Just try it, you can find your place here even though it's a big school." If you want to branch out - like reach out your comfort zone, Rutgers is big enough to do because there's so many things going on. You can go on a new campus and each campus has a new experience, and that's something that I love because you can do something new every day. (Elena D.)

> I see Rutgers as a very well known school, overall. And, I just like the environment because it a very nice big school, I know that scares most people

away; but ironically enough I actually kind of thought it would work because it's big so it's very easy to kind of hide in the crowd. Another thing is the department as well; there are many departments. I feel Rutgers, it has a strong engineering program and as well strong other departments because I was just thinking that it is kind of silly for an engineering major to be a minor in English. It's really not a combo but I really like English and I don't want to give it up and I do want to pursue engineering as well. So I thought and at school here again I think it's more focused for it technical side of things doesn't really leave much room for anything else. But, I thought I could get a little bit of everything and still receive a very solid education. (Ann G.)

It's close to home...well not too close to home, anyway. I know Rutgers had a really great and big research program and facility. So, I've had research experience before so that's what got me into Rutgers. (Harriet D.)

So, it's awesome and interesting dynamic [chuckles] because Rutgers might have been one of the better engineering programs out of all the schools I applied to. I did consider University of Virginia because that was less expensive. But, I found difficulty there, and I found difficulty at Cornell as well. And aside from that, the convenience is amazing [chuckles.] I complain when I'm trying to get home and it takes me an hour because there's traffic [laughter]. I have some friends have plane rides and all that stuff. Overall, it enabled me to stay close with my family. I didn't go home for the weekends or anything like that, but if my parents wanted to come for dinner, we go to the Rutgers Club or stuff like that. So, it kept my family close and also made the most sense financially, and then I was really excited after coming to Rutgers to the engineering open house. It really highlights how cool engineering is and really gets you excited about engineering at Rutgers. (Jayne W.)

I compared the ranks between TCNJ, Rutgers and NJIT, and Rutgers had a better rank as well as the fact that when I came on the tour of Rutgers, I felt a bigger campus for someone who is going live on campus is probably more fun for me as far as not feeling in closed space all the time. Rutgers is significantly closer to my house than the other schools I considered, so my parents would be able to drive and come to see me more often. So those were the some main reasons. (Mary A.)

6.8.2 College Costs

Approximately 48% of the students indicated that they chose Rutgers University-New Brunswick because of the reasonable cost of tuition, scholarship offered by Rutgers, and scholarship offered by Douglass Residential College. The ten participants who enrolled in Rutgers – New Brunswick due to financial reasons noted that Rutgers tuition was affordable and many of them also received scholarships making it more financially possible for them to attend college.

Financially it was ok. It’s not like twice the debt that you would have in some other institutions. (Cindy N.)

> Probably the number one reason I came Rutgers was the financial situation. I didn't feel defeated by the other schools or anything like that. If I put everything that I could into it, then I thought I would get a ton out of it. And, then also financially speaking, I wouldn't come out with any student debt or loans or anything like that. So that was really the deciding factor. (Jayne W.)

> What made me choose Rutgers is just the package I was offered. I got a scholarship the honors program. I took the honors program and the merit-based scholarship. That's pretty much why I chose Rutgers. (Diana S.)

6.8.3 Influence of Friends and Family

Ten students (48%) indicated that they selected Rutgers University – New Brunswick because of the influence by family or friends. Some students initially considered that because family members had attended Rutgers, it was a deterrent for them to also attend Rutgers. However, they changed their minds after visiting the campus and as a result determined that the school was a good fit for their career goals. Other participants who had family or friends that attended Rutgers were already positively influenced by the good experiences that their family members or friends had told them about and subsequently they were ready to choose Rutgers.

> I also have a sister that goes here so she kind of pushed my Rutgers's pride and I really enjoyed the program when I came here to visit. (Jenny P.)

> Well people close to me, my friends who have already joined the university, like have been attending the university, they said that engineering is really good (Judy N.)

> Rutgers was actually one of my last choices. I really wanted to go out of state and do my own thing, get away from my parents. They're really strict. I mean it worked out but I wanted my own life. And, then I realized it's a lot of money. I didn't get all the scholarships I wanted to get and then I went down to U Mass and then it was just not what I expected. So I looked at Rutgers and one of my best friends was actually going there also. So, I was like, all right you know what if I go to U Mass I won't know anyone. At least at Rutgers I have a friend there. So I went to Rutgers and now I love it so much. (Sandy F.)

6.8.4 Why Douglass and the Engineering Community

A thematic analysis of the reasons why the participants self-selected into the women-only engineering living learning community through Douglass Residential College revealed a belief in being able to immediately become engaged in a comfortable space for women. All of the participants indicated that they expected the engineering curriculum to be challenging and anticipated the positive support that they would get from other women who would be taking the same classes. A women-only living-learning community offered the hope that being surrounded by other women (who would be going through the same things they would experience) would be helpful and provide a network of support. The students also spoke about whether or not they felt prepared for the rigorous curriculum in the school of engineering. The opportunity to reside on the Busch campus was an additional benefit so that they could live on the campus where engineering was based.

6.8.5 Anticipated Support

Even before entering college on the first day, all of the participants did anticipate support from their peers (women engineering undergraduates) and staff in the living-learning community. All participants expected to immediately benefit from a community of women, describing them as " Community, connections, or friendships 171 times. Their responses indicated the significant value of community, support, and friendship they can benefit from by joining the Douglass Residential College and the community of women engineering students.

The participants anticipated that the outcomes of participation in the Reilly-Douglass Engineering Living-Learning Community as being surrounded by other women in the community who would be going through the same things that they were experiencing. They anticipated peer support with coursework, immediate friendships, and a network of support from others. Some students indicated that they are typically shy and it's hard for them to "put themselves out there." Therefore, the community of like-minded engineering women could facilitate those friendships and connections to others. Being part of a supportive network was important to many of the participants because some were intimidated by being outnumbered by men or thought that their abilities in math were not as good. They anticipated that the women in the community would be reassuring and helpful.

For the Douglass community, I joined because I felt it was a good idea to be with women who were going through the same things that I was going through. I had a couple of friends coming into college from high school, but none of them were really engineering. One of them was, but I didn't know that she was going to engineering and I didn't know she would be in Douglass either…. I felt that having all girls there it would make me more comfortable with myself. They would know the issues I was going through. We could talk about women things or something like that. I think it was my decision at first. I know my mom asked about it, and I guess she said it would be a good idea to be with engineering girls to see if they could be either for me as a support rather than just friends. I looked into it, and it was sort of. I didn't really know much about it at the time when I applied for the Douglass community, but it was one of those chances of a lifetime that you look back on, and it's like that's one of my best decisions that I've ever made, and I don't regret any of it. (Elena D.)

I learned that there is a program that Douglass had. It was a very interesting support from woman and I felt like that was definitely something I was lacking because even at high school once you get up to the higher science courses, it starts to become more male. I think maybe it could be a little silly to say this but if girls were around I would feel maybe more comfortable and if I am doing a problem even if they are finishing fast I may not have to compare myself with them as strongly <as I would compare myself to men>. So I thought Douglass could be a support just because I heard they were only for females; so I thought I might be more at ease with being surrounded by girls. I do remember hearing about this ratio of 50 something guys to 19 girls, so… (Ann G.)

At Douglass there's a lot more people that have their hands out and they're like, "take my hand; we can get this done." So I definitely felt like I would gain a lot of academic support and the community aspects was really important to me. I really felt like this was a community that could foster my growth and my development. I thought I would get more support like more academic support was probably the main thing. Then I also thought I can get more friends more easily. At an open house and they were saying that Douglass women have high grade point averages, but that they didn't necessarily come in with the highest grades or SAT scores, but they left with some of the highest grade point averages… It was something that I guess my mom thought would be conducive to me and I agreed as well because I'm somebody who always wants to be a part of something. If I'm not a part of something, I feel like something's a little off. So Douglass was the first thing that I could be a part of that I felt would also open some doors for me and allow me to meet so many cool people because I had met so many awesome women at the open house. (Jayne W.)

I joined because I knew beforehand the low numbers of women in STEM and how hard it can be, especially when you're entering a field that's predominantly male. So, I wanted the community aspect. And I was a budding feminist at that time, so I wanted to give back and encourage other women to do likewise, to build the community and also give back to community. (Veronica K.)

Having that support system was very, very nice to know about. I looked into it when I received an email. I didn't know that Douglass College, to be fair, existed until I received that email. I applied and got the scholarship and then I looked more into the opportunities it offers and reading students interviews or what students have to say about the programs itself that was one of the big factors that led me to Rutgers…I expected to gain support because I didn't have that. That was one of the big things that I was looking for, especially because, even though when I was at the Cornell University program for high school students, I realized that I was one of the few [women]. It was very, very intimidating. You have these students from the best of the best all around the country and me coming from a high school that I knew did not prepare me very well. I expected a lot of support. I expected that there would be women around me and we would be there for each other and Douglass definitely helped me with that, for sure. (Randy S.)

I did the Douglass overnight and that was a really cool experience. So many different people, the person who hosted me was so nice, and she took me to classes, and it was just really interesting and it seemed like a lot of fun. What got me to [join] was we had an orientation session, and they were saying that Douglass students have high GPAs like they didn't necessarily come in with the highest statistics, but they left with highest statistics. I really felt like this was a community that could foster my growth and development. (Jayne W.)

In high school, even in my engineering courses I noticed that the first year was like pretty even split [of men and women] and the second year it was mostly guys and the number of women in the class just became smaller and I think I was the only girl in my 2nd year. So it was a small class and mostly male and almost no female, I thought this could be a bit of a blow to my ego but [I began to think] where I just see it mostly male, a lot of my male peers were better than me mathematically. That kind of made me feel bad, given my best friend who was sitting next to me in the class and he done with his worksheet maybe like 10 or 15 minutes. Most people in the class [were men and finished engineering worksheets faster] but I am just sitting next to him still on problems while his is already done. And, that just started to get into my head and I start thinking, oh no, what if what I am doing is wrong. I am taking too long on this problem. Am I not doing it right?" That just starts to get on my mind and it's a little distracting so I think maybe it could be a little silly to say this, but if girls were around I would feel maybe more comfortable and if I am doing a problem even they are finishing fast I may not have to compare myself with them as strongly. So, I thought Douglass could be a support just cause I heard they were only for females, so I thought I might be more at ease surrounded by girls. I heard about this ratio of 50 something guys to 19 girls. (Ann G.)

> So it’s just a bunch of girls doing the same thing as me, so [I thought] that’d be cool. Most of my friends were guys so I thought maybe I could branch out and make friends out of those girls and have like lasting bonds. So, I joined. I just figured it would be [good] to create a network. (Sandy F.)

> Seeing how it was just a network of girls, I see how that could be beneficial to me when you’re already a minority as a female so why not have a group of minority females just to make what you go through a lot simpler. (Tina K.)

> I know there are not many women in Engineering, so it's going to be a struggle anyway. So, I thought why not have a support system? (Olivia S.)

In addition, almost 25% of the participants appreciated immersion in a community that had a foundation based in feminist ideology. Several students indicated that they had chosen Rutgers University – New Brunswick because of the availability of the single gender living learning community for engineering women. They anticipated that the layers of support and resources would provide an environment in which they could succeed. This was seen as particularly important in a major that they anticipated to be demanding.

> I joined because I felt it was a good idea to be with women who were going through the same things that I was going through…Since we're all women, we

> know how each other feels and we know how to comfort each other in a way that I don't think the males would understand. (Elena D.)

> I joined because I knew beforehand the low numbers of women in STEM and how hard it can be, especially when you're entering a field that's predominantly male. So, I wanted the community aspect, and I was a budding feminist at that time, so I wanted to give back and encourage other women to do likewise - to build the community and also give back to community. (Valerie K.)

> I received a letter, a note from one of the previous girls. You know they're saying, "Oh, you'll have like this group of friends that could help you out through the whole Engineering first year experience. And then there's housing living with other Engineers, and there is also tutoring help and advice if you need anything." (Harriet D.)

All students reported that they expected to gain support, networks, and friendships from participating in the Reilly-Douglass Engineering Living-Learning Community. Fifteen participants indicated that they were not initially looking for a women-only living option. Eight of them revealed that they were initially reluctant to live with only women. Although some had initial feelings of reservation about living with all women, after living in the community for at least one year, the majority indicated that they benefited immensely from the experience and didn't know what they would have done if they didn't have the community as a supportive base.

> Before I joined I'm like, "I don't want to live with all girls. There could be too much drama." (Judy F.)

> Living with all women actually made me not want to do Douglass. I just came from an all girls private school for five years. I didn't want to live with all girls. Yes, I remember now, that was my biggest concern. I just left an all girl school…I wanted to use college as a time to broaden out. In middle school for my 6th grade year and in elementary school I was with boys and stuff. I don't remember that, so I really did want to branch out, do something kind of new because, you know, girls are like definitely the minority in engineering and I think it's important to kind of really have that mix just because you have it in the real world so that made me not want to do Douglass. (Tina K.)

> I had a friend who was doing that, living with all girls from high school, and I was like, "there's no way I would ever sign up for that." I could not do it. I have two sisters. I know how it is living with just girls. (Sandy F.)

The following themes specifically describe participants' social, academic and gender-differentiated experiences

6.9 What They Experienced in the College

The themes that emerged from the analysis of the qualitative data were centered on social connections and network relationships, academic and classroom incidents, and differential treatment that the women in the sample experienced during their enrolled as an undergraduate engineering student. The social experiences and outcomes were the most frequently discussed theme. Social experiences included: the community aspect of the Reilly-Douglass Engineering Living-Learning Community, involvement in college clubs, organizations on campus, and friendships. The impact of participating in the living-learning community was the second most frequently discussed theme. The participants revealed what motivated them to continue when things became difficult, things or people that intimidated them, and the experiences, skills, and knowledge they felt helped them to further develop. Academic experiences were the courses taken for their major and also included how the living-learning community course-in-residence impacted them, the difficulty level of the engineering program, and how participating in Douglass Residential College and taking the Douglass Course impacted them.

The participants also discussed resources to which they had access by virtue of enrollment in the Reilly-Douglass Engineering Living-Learning Community. Examples of resources and supports included: tutoring; peer mentors (women-only); faculty mentors; staff mentors (women), connections to research in their first year; tutoring; specialized hands-on Engineering Explorations course; a graduate mentor in residence; free trips to engineering-related places such the nuclear power station with tour; and access to all career and professional development, special lectures, and leadership opportunities available through Douglass Residential College, the School of Engineering, and Rutgers University. While some of these resources are available to any Rutgers student, they would not be "packaged" and intentionally layered in the way that they are for the students in the Reilly-Douglass Engineering Living-Learning Community.

6.9.1 Social Experiences

Community, friendships, mentoring, and involvement in co-curricular activities were the themes that emerged as social experiences. When speaking about "the community," students primarily spoke about the common experiences that created strong bonds between women within the Reilly-Douglass Engineering Living-Learning Community. Table 18 summarizes the social experiences of women in the engineering LLC.

Table 18. Social Experiences

Social Experiences		Student Replies Count (n)	Student Replies Percentage
The Community			
Common experiences		20	95
Overall positive experience		20	95
Connections / network		17	81
Comfortable space for women		16	76
Friendships			
Majority of friends are in R-DELLC		19	90
Peer support from within R-DELLC		19	90
Strong bond to women in R-DELLC		17	81
Socializing/doing things together		15	71
Did NOT connect in R-DELLC / most friends outside R-DELLC		2	9
Mentoring and Role Models			
Peer-to-peer	women	21	100
	men	2	9
Faculty / staff	women	20	95
	men	11	52
Co-Curricular: clubs, leadership, sports, etc.			
STEM-related organizations/clubs		20	95
Non-STEM clubs/organizations		11	52
Leadership or student government		9	43
Sports or regular exercise		6	29

n=21 participants (20 retained and one who left engineering in year 1). Note: Each percentage was calculated based on the total n=21

6.9.2 Community

Students identified that a main reason they chose to enroll in the Reilly-Douglass Engineering Living-Learning Community was because they anticipated belonging to a smaller community within engineering and within the larger University. All participants stated that a supportive community experienced by each cohort met this expectation. More than half of the students identified that living together was fundamental in creating the community.

Participants described how the community was created. As the engineering women lived together in a wing of a co-educational residence hall, their proximity to each other facilitated the opportunities for communicating with each other, getting help with homework, and socializing. A social network was created by a common major and taking Douglass courses together. In particular, in the first year, students take common classes that helped them to share information and rely on each other for help. When they had one or more classes together, they would often travel to class with each other and sit together. The participants indicated that sitting with each other and being with other women who were not in the Reilly-Douglass Engineering Living-Learning Community, was helpful because there were always many more men than women. Participants would often eat together or study together. Living in close proximity, having common academic classes, eating together, and studying together helped to create the social network from which members benefitted from a spectrum of support.

> We had Chemistry together and we had Physics together. So, we would usually sit together in class. Go to breakfast together, and then go to class, so that bonded us. (Elena D.)

One of the best parts of freshman year was that we would all sit together in lecture. So, freshman year we were all in the same classes together because you are in general engineering classes… we had the same homework, so that's what brought us together. (Annie C.)

There's a common thread. You feel like, "We're DELLC girls" or" like Douglass girls." It was nice. I guess it's just everyone's trying to figure out who they are in the first year, and it's nice to be part of Douglass. With Douglass that's like a common connection. (Amelia O.)

We got close because a group of us were in the same Calculus class. So, then we'd walk back together. We are on the same floor, we are taking the same classes, even if it wasn't the same section. (Harriet D.)

I had like four or five Douglass-mates in my community. We took the same classes and it is really helpful because a lot of the time when I don't know a question they know the answer to and when they don't know a question they ask me and we help each other and that's really nice, and I felt like that support really helped. I felt like in a way other women in engineering <who were not in the Douglass community> were kind of jealous that we had each other. I felt like that`s one of the strengths that Douglass has. We know that we all have each other because we are in this together. We are all in the same boat, and we all help each other. Yeah, that`s one of the things that Douglass really has to offer. (Heidi Y.)

I definitely say that because of the shared experiences and to know that a lot of the students will be in class together was really helpful. That was cool because we got to do different projects together…Overall, it was very cool because you really realize that anybody in the community is somebody that you can talk to, which is absolutely huge. Everybody has it hard, so you'll be talking to people and some people are like, "Oh I have three exams next week." And you're like, "Oh, I have two, I thought that was bad." So then you start to hear stuff like that just in passing, then there's always a smiling face. I think being together in the DELLC community, we did hold the same ideas, to certain extent. Those ideas that I still hold today, and those ideas that I want to continue to hold, and I think that's where the comfort comes from, I know that I can confide in these people and I know that they can understand where I'm coming from in comparison with people on other floors who haven't gone through the experience that we had with Douglass and with all the things that we've learned that they haven't learned. (Jayne W.)

For our sophomore year, we were willing to kind of like fight for our housing together because we were like, “How can you separate us? We're inseparable now.” (Annie C.)

6.9.3 Friendships

All of the participants spoke about the supportive relationships that were formed in the Reilly-Douglass Engineering Living-Learning Community. Peer support ranged from help with homework and study groups to strong friendship bonds within the community.

> Rutgers was a big campus and overwhelming because there are thousands of students on five campuses. But, I felt within the Douglass community and in engineering itself that I found my own group of friends, my own community, and I felt welcome there. I found the support that I needed to get through my classes, go day to day, I found people that I'm comfortable with….It's very important to find a good group of people that you can stick by with, and you can just tell each other everything, that'll be there for you. That's what I found in this group of girls. (Elena D.)

> I felt this community gave me the friends that stuck with me for the past four years…these are my best friends that I found in Douglass. It's like we made that part of our hallway just "the DELLC hallway." We always would just walk to each other's rooms doing all the DELLC girl stuff, pulling pranks with each other or like staying up all night doing homework. I felt that having all girls there it made me more comfortable with myself. They knew issues I was going through, we can talk about women things or something like that. It just made me more open to the idea. And within that hallway, I became more open to walk into the other hallway, which was co-ed. I became a more outward person. So, it just helped me start reaching out more. (Elena D.)

I was actually glad I joined it, because I mean I am not the kind of person that makes friends really well and I don’t usually take the initiative to make all the decisions. I am glad that I did Douglass because that sort of forces me to meet other people and definitely it give my life support and not just the mentorship program were there giving us some mentoring. (Heidi Y.)

I thought my high school friends would be my high school friends forever. I don't need anyone else. And that's truly what I'm most thankful for at college is for the DELLC, because everyone was so friendly. They were willing to give me their time and their friendship…the first year when we left for like winter break I started crying because I was like, “I'm going to miss you guys so much.”. Some of my other friends got teary-eyed but like just in a matter of 4 months or so I went from being completely like tortured, pretty much what I would say is coming to college - to crying because I would miss my friends for a month. And that was due to DELLC entirely and I was very grateful for that…Something that stands out to me immediately about the DELLC is that there's a social aspect. And reflecting upon the other female engineers not in the DELLC, I feel like for them it was a little bit more isolating because I immediately know who I could go to if I ever have any kind of problem. I tend to find that DELLC women are more extroverted than introverted. But, I know it's kind of a stereotypical quality of engineers to be introverted. Like the girls on the Honors floor, they were not part of DELLC. They were really very introverted and I think when you went to the

> DELLC floor you definitely knew they were not introverted. There was always laughing and it was fun….DELLC has given me lifelong friends because they're like my closest friends and I really have that community to thank for it because they are my leaders, they're my supporters, they're my best friends and so it goes way beyond and you're just another member of the community like I'm going to miss the girls in my class s much and it's crazy because we're graduating in 5 days and we're all being kind of dispersed throughout the country but the thing that brought us together was freshman year DELLC and that's what I'm going to miss so much, the thing that held us all together wherever we are from. When something gives you your best friends it's hard to even put into words what that is, but it is DELLC. (Annie C.)

6.9.4 Layered Mentoring

Mentoring for the community was provided in a tiered and layered format. Each year, the living-learning community had an upper class undergraduate student who was majoring in engineering or a closely related live in residence with the Reilly-Douglass Engineering Living-Learning Community first year students. Their role was to build community by offering engaging programs and encouraging the students to attend Douglass-sponsored events on other campuses, particularly those held on the Douglass Campus (approximately five to seven minute bus or automobile ride between campuses). In addition, a graduate mentor '(slightly older' student in the same major) was assigned to the engineering community to provide tutoring, guidance, advice, and support. The graduate mentor either lived in residence or have office hours and meetings scheduled on a regular basis that enabled frequent interactions with and among the students in the community. After its inaugural year, another layer of peer support has been provided by students who had been in the community for a year who become peer mentors to the incoming cohort of Reilly-Douglass Engineering Living-Learning Community students through the "Big/Little" program. Big/Little refers to the upper year student (sophomore and above) being a peer mentor and acting as a resource to the incoming first year student. Sometimes, the struggles and difficulties of peer mentors were inspiring to new students and helped build resiliency and a pathway model to achievement.

> Just by her [peer mentor] showing me that I can do what I want, knowing that people have struggled and still made it out - she got Cs in chemistry and still went to Berkley California for her grad degree in biomedical engineering. Another student in engineering, upper class, too, you know she failed Calculus 2 when we took it and still she had this awesome internship that she's so happy at. It's great to hear about these role models, so I feel they're role models because it's so nice to be able to relate to them when you have struggled, too. I think, "oh, am I going to make it there?" But when you hear all these stories, they struggled, they've been through it, they've made something really good out of it. It's like they're role models to me because I want to follow in the same steps. (Cindy N.)

In addition to peer mentors, the faculty mentors provided another layer of guidance and support. In particular, women faculty in the School of Engineering, were identified as mentors and role models. The students recognized these women as an inspiration and important motivation for persisting when things got difficult. The students benefited from the mentorship of both men and women faculty and staff. However, women faculty and women staff members were identified role models or mentors by 20 participants. Approximately half of the participants indicated a male faculty member as a role model or mentor.

> The women professors - the fact that you can be a really successful female engineer... they're older than me, so even back in the day when it was harder and not as common for women to become engineers, they still did it and they have amazing careers. They've traveled all over the place, they've done amazing research, they've been to conferences, they give classes for graduate students, they have all this innovative research that's happening that is very real in the field of engineering. To have them as your professor, it's very humbling because you're like, "Wow this person has done so much in her life and still coming back to teach me about the field." (Judy F.)

> Having a professor who is a woman engineer, especially women from different departments telling us about how their journey was and knowing that it was also difficult for them was inspiring. You can see yourself in their place, you can see yourself as successful. The road is not the same down all the way and when the mechanical and aerospace professors came, I think we had two and it was like, "this is what I want to do, definitely." Meeting the women engineers helped to break it down for me. At the point where I decided that this is what I want to do and because they had interacted with us, they were very friendly even outside of

> class. After, when we were done with engineering explorations class, I was able to go to those professors and interact with them and ask them for any help that I needed. (Randy S.)

> I think for me, having those role models as my professors or just having people in my sorority or women in my classes and people in DELLC that are women engineers is definitely helpful to combat anything that people say about, …"why are you an engineer if you're a woman." (Judy F.)

6.9.5 Engineering Explorations

The Reilly-Douglass Engineering Living-Learning Community had a three credit "house course" that was part of the experience. The course was Engineering Explorations. This course was available only to women in the Reilly-Douglass Engineering Living-Learning Community and taught by a tenured woman engineering faculty member. As a small class, the professor has a more direct relationship with the students and had the opportunity to get to know the students who were directly engaged in the course. This course helped the women to explore the different engineering options for a full semester, which was their first semester in college.

The course is designed as a hands-on experience. Women faculty members are invited into the classroom to describe their area of engineering and welcome questions from the class that is comprised of only women students from the Reilly-Douglass Engineering Living-Learning Community. Many students indicated that the course was helpful in guiding them in deciding which area of engineering is a good fit for their interests. As this course is offered in the first year, students stated that the course helped prepare them to declare their specific engineering major.

> I talked with friends who weren't part of Douglass about what their equivalent course was, and for us it was pretty cool because it was a lot of hands-on stuff, it was a lot of we built our [structures] and put them on shake table and watched our beautiful creation. Again, it was with all those girls we lived with, so it was fun because we were like, “Ok guys, we're going to class now,” like all of us come into class. And if we had homework assignments from there or group projects, we already know the girls who were in the class, so we can say, “okay I work better with her,” I'm able to... she might be a little more on the shy side, so I can maybe help her find another person and the room that would fit better with her. After talking to people who were just in the general [Rutgers] engineering exploration classes. The setup of theirs was more of a big lecture hall, and then people just talking at them where we would have people like our professor come in and teach us one-on-one, which helped me because coming from that small catholic school, that's what I got there, so it reminded me of that one-to-one student faculty interaction that... it's a lot easier to learn and stay engaged when people are in a smaller environment as opposed to just sitting in a lecture hall and being lectured at. (Judy F.)

> One thing that I liked about this program was when the professor brought in some of the professors in different fields and I was actually able to speak to one of the professors. I was interested in the environment. So, I wanted to see maybe going

> that route is going to be an option for me. I was really glad that I spoke to her because a lot of things that she told me was that people ended up like something to do with landscaping which has another chemistry side of it so which is why I knew that I probably don't want to go into this. I was so glad that I was able to speak personally to the professors to have a deeper understanding of each field because other than that it is really hard to speak to professors about anything like that. And it is really difficult for students especially freshmen to meet with people that have sort of experiences in their field. So this class kind of opened that door for me. (Heidi Y.)

6.9.6 Faculty Support

Many of the participants also identified a specific faculty member assigned to teach the house course for the living-learning community as a pivotal person in their life. As the professor saw the students each week, she developed a relationship with each of the students. This relationship was important in motivating the participants to continue in engineering.

> The women professors, like Dr. Bu. that I had for class freshman year, she was best professor ever. I was really motivated by that [she was a woman] and I can really relate how great professor she was. It really motivated me to do better. A lot of male professors I feel like, it's just my personal experience, they disregard certain concerns or they don't... it's straightforward for them, they're like if you go for them for help or something like that, it's harder to hold conversations. I wish it were easier to do that because I felt like if there were more women representation, I would feel more comfortable, in a sense. (Mary A.)

Dr. Bu. She was very fantastic. She definitely was a huge help. She was like, "You're going to be okay." She told me a lot more about. She was one of the big components that helped me. Like, maybe there's a different track I could go on in engineering that will open up a lot more doors and I could still end up going on my original path to be an engineer. (Myrtle M.)

The Engineering Explorations class, I loved that class because it brought us all together before we all separated into our majors. We all got to do projects together and was a nice environment. It was relaxed and Professor Bu. was very approachable, and I we felt we can ask her anything. It was a really good class to come into Wednesday morning and listen to people talk about their majors, and we talked to each other about what we want to do, what our interests are and feed off each other. (Elena D.)

I was very surprised with the benefits that came with being in the Douglass community, especially the engineering explorations class. The engineering explorations class <was good because> we get our special class and it was very nice because they scheduled professors in each major to come and speak to us. I think that really helped because it kind of gave us like a sneak peak of what each major will be like and it definitely helped me made the decision. I was really glad that we had our own class and we were able to explore other fields and data and to be able to take class with all the Douglass girls. One thing that I liked about this

> program was when the professor brought in some of the professors in different fields, I was actually able to speak to one of the professors…I was interested in the environment so I wanted to see maybe going that route is going to be an option for me. I was really glad that I spoke to her because a lot of things that she told me was that people ended up like something to do with landscaping which has another chemistry side of it. So, which is why I knew that I probably don't want to go into this and I was so glad that I was able to speak personally to the professors to have a deeper understanding of each field. Because, other than that it is really hard to speak to professors about anything. And it is really difficult for students especially freshmen to meet with people that have all sorts of experiences in their field. So, this class kind of opened that door for me. (Heidi Y.)

6.9.7 Staff Support

The staff involved in the administration of the living-learning community provided a final layer of mentoring and student support. Some staff were assigned as facilitators with the School of Engineering in addition to full-time staff who were assigned as a project manager, mentors, and facilitators at Douglass Residential College. The staff in the School of Engineering also did academic advising. The staff at Douglass Residential College offered non-academic mentoring, planned professional development and career programs for the students in the LLC, provided free tutoring, ran trips (such as to the nuclear power plant), and offered 'de-stress fests' during exam time.

> From my experience, I think that the Douglass community was absolutely instrumental because of the people I met. The people that I met were so helpful so fantastic, and Ca. is obviously really amazing, I certainly wouldn't have felt as

comfortable just showing up at her office unless she came to us and said, "Hey you guys can show up at my office." Then I certainly wouldn't have felt comfortable doing that, so I don't think I would have gotten the confidence that I know have. (Jayne W.)

Rutgers is so, so, huge. It was nice to see that right off the bat we had people that were willing to support us, not just other students, but also adults and faculty members like, "Hey, we are here for you if you ever need anyone to talk to." So, having that right off the bat on day one of school even before classes even started, that was just extremely a very nice calming thing…Having additional people to go and talk and to, it helped make a great connection with Professor Bu., with Dean Wh., so, it was definitely a great way for us to start networking and actually get a leg up over the rest of the Rutgers community that didn't go and talk to the heads of the departments. (Myrtle M.)

So, Dean C. Wh. from the School of Engineering, like I'm in her office at least three times a semester. I'm just like, “let's talk about life” or about what my problem is. I'm just like, “okay, let's do that.” I tell her what's going on she's like, “Oh, I can do this for you because C. does so much for all Douglass women. % She does everything because I remember one semester I had was trying to register for a class and it wasn't the right one. I email C. at like 10:00 p.m. saying, “C., can you help me with this?” And, I wake up the next morning and by 8:00 a.m.

and C. had already replied to my email and was like, “I already registered you into the class.” So, I'm like, “Wow, thank you.” (Olivia S.)

6.9.8 Co-curricular Activities

Active participation in extra-curricular or co-curricular activities served to engender additional connections and bridges to other networks related to engineering groups and activities. Participants from each of cohorts stated that they were engaged in college clubs and organizations that promoted women in engineering. Through the Rutgers chapter of the Society of Women Engineers (SWE), the students visited high schools to help prospective college women learn and get excited about the possibilities in engineering. Many were proud of being a role model to younger students and gain leadership experience. Being a peer mentor and/or involvement in engineering organizations helped to reinforce commitment to the field.

Ninety-five percent of the students in the living-learning community were involved in clubs, sororities, and organizations. Ninety percent of the participants were engaged in engineering-related social activities devoted to women-only such as, Phi Sigma Rho, which is the sorority for engineering women, and the Society for Women Engineers (SWE). Fifty-two percent of participants were involved in non-engineering activities such as social justice, a comedy troupe, faith-based student organizations, cultural clubs, youth group mentoring in the community, hiking, power lifting team, regular personal fitness, and the theatre group and the school choir. Twenty-nine percent of the students were engaged in regular exercise. The students felt that the clubs and organizations allowed them to pursue their personal interests and enabled them to meet people who were outside of the engineering major.

I played basketball. That was great because it was pretty much all guys. There was one team that had 3 girls but it was pretty much all guys, so that was interesting too because sometimes I would get contact, but other times they would just let me right through. That was a lot of fun, so that was great. I'm going to definitely keep doing it... I also did Frisbee as well, so I'll definitely keep doing intramurals because I really missed out on the team aspects. (Jayne W.)

I ended up making a volleyball team. (Elena D.)

I found the Rutgers triathlon team. I knew how to run, bike, and swim, that was something different that I could try. I emailed the president, and they seemed really friendly and very encouraging, so I jumped right into the team in my freshman year. I'm so happy that I did. I actually competed in two collegiate nationals races in my time here, every time I tell people about it, they're like, "Wow that's impressive." It's cool with the rest of my teammates. That was cool because for me, I really like exercising as a form of stress reliever. If I had a hard time with one of my class, I just go for run or go hang out with my team, like go for swim with them, that would help tremendously. (Judy F.)

I'm on skate team. (Renee T.)

I was part of the voice choir, which was great because every single one of them was in Douglass Residential College, but all majors. Even though we all sang we were all doing something very different, which was amazing because we would come together and sing and that was something that brought us together. And we have all these different societies - a lot of them were in neuroscience, scientists and business majors and I was the only engineering student there, but it was nice that we could all interact and share our knowledge. I definitely did not envision myself getting involved in 90% of the things I did or do 99% of the things that I did. I thought I would come to the school of engineering and that's what I'll be doing but the big part - 90% of it - was non-engineering because I wanted to attain those skills. I know I'm attaining some of these skills from class; but I know I had to attain other skills from other things as well by getting involved in social things or any political group or habitat for humanity and things like that. I thought that I would be going to engineering and that's what I'd be doing all the time, but things have been a lot better and a lot different (Randy S.)

I'm part of a youth group. We do a lot of outreach program, so sometimes you go to the food banks. We do a lot of donations like we donate clothes, food, helping the unfortunate. (Harriet D.)

I also joined theatre groups. (Sandy F.)

That's just cool because once you start digging into all the different clubs or resources Rutgers has, even though it's a big university, it becomes so much smaller, and I can walk around campus and say, "hi" to a bunch of people and

> they're like, "Oh you're so popular"… it really makes college much more of a great experience. (Judy F.)

6.10 Outreach and Recruitment

Another recurring theme from the qualitative data was the intentional recruitment of high school women students into college engineering by participants who were intent in letting them know about the Reilly-Douglass Engineering Living-Learning Community option. Participants encouraged them to apply to Rutgers and join the women-only community. In fact, one of the first-year students interviewed stated that she did choose Rutgers because she found out about the Reilly-Douglass Engineering Living-Learning Community when she was still in high school. She knew she wanted the supports embedded in the School of Engineering and at Douglass. She also stated that college women seemed so nice and helped each other. She wanted to be part of something like that.

> What I found the most beneficial was when high school girls would come to Rutgers and a bunch of the Reilly-Douglass Engineering Living-Learning Community girls would speak to them and talk about our majors, and we would do activities with them like building a roller coaster, which is really fun. I feel like it let me be a leader when I never saw myself as a leader before. Most of the time [I was just] a follower, but the Douglass program showed me that I have the potential to take charge, advocate, bring more women into STEM, break the stigma of being in a male dominated area, and recruit more women because women empowerment made me feel better about myself. In a way, it let me see

> how I see the world and develop my own opinion about things since I was shy back in high school, I broke out of that, I speak out for myself more now, and I want my opinions to be heard. I feel like Douglass has given me the push to become a better person, become stronger minded. Sometimes I think about this, but in my classes I guess 30 people, there are only 4 girls in the class, but it doesn't even phase me because I'm just one of the students. It doesn't bother me that there are only four girls in the class. Douglass has helped me find a place where I had that confidence in myself that I'm just as good as every guy in the class. And, that's something that has really empowered me and something that I love to tell to younger girls. I always tell them, "don't be afraid because you're going into a male-dominated field. If you do your work and you start believing in yourself, [then being one of the few women] won't even phase you." (Elena D.)

6.11 Outcomes: Motivation

6.11.1 Motivation to Persist

While students indicated that the engineering coursework was demanding, only 57% of participants had seriously thought of leaving the engineering major at some point but decided to stay. Persistence in engineering was explored in the interviews. Students revealed several reasons for persisting when things got difficult. Some students relied on the support from their peers in the living-learning community (external support). Students also indicated that they were self-motivated with an internal drive to succeed.

I like Engineering. I enjoy it. And, also, I don't want to quit in the middle. I want to stick with what I know and improve upon like make my skills in engineering better and do something impactful with it. So, that drive is there. (Diana S.)

I know some students just go for the grades, but I go for the topics, and then I see the grades as a reflection of how well I know that topic. (Jayne W.)

Actually knowing how to do things keeps me going. Even if something is difficult. I didn't want to just get through it. I want to learn because I know at the end of the day, it doesn't matter what my GPA is; but, I know if I understand it. And, that, at the end of the day, I can take all this information and apply it to something bigger and help people. That really is my ultimate goal. That keeps me going. (Randy S.)

I pull myself together and I say to myself, "Stop, just stop. You're doing this for other people." I want help people grow up. I want to teach kids, I want to help young girls. That just keeps me going at it, I'm like, "No, you have to keep going at it. It's okay if you fail this class, take it again, it's not the end of the world. You just have to remember that it's not the end of the world, and you'll get through it." (Penny M.)

I feel like if you do what's easy then you have a hard life; if you do what's hard then you have an easy life. So, it's like you can't see now what you're going to do next, but there's a light at the end of the tunnel. For example, today I put in the work and I thought, "Oh, it's not working; you want it to be perfect? I doesn't have to be perfect as long as I understand it." People want to go for a major and have a 4.0 GPA in that major. But, you can't do that because it doesn't just work out like that. You can't give up because the most inspiring stories are not people who've always had it right. The inspiring stories are about people who've managed to overcome big obstacles. I am not the one to give up, ever. I am very stubborn in that sense. And it helps, it pays off because I wouldn't be who I am if I wasn't still trying. Even trying AP English courses back in high school, people were like, "Oh but you're bilingual you can't do that." And, I am like, "Oh, just watch me do it." It's just about accepting that sometimes it works and sometimes it doesn't work. You just have to challenge yourself because it's better to be average in the major leagues than to be the number one person on the minor league. So that's how I keep going; I just say to myself, "Oh, I can put in the work." And, all I can do is give my best. (Cindy N.)

You just keep your head down and keep pushing through. I'm tell myself that I'm trying," and eventually I'll get somewhere else than where I am now. I just felt like, "Okay, I guess it just takes learning things if you weren't taught that when you were younger." You think that sort of way in sports. You would just keep going; put your head down and keep going. You learn that, but I guess it wasn't until I was doing myself that really depended on my own drive. Like you have to rely on yourself to get things done. (Amelia O.)

> I don't lose sight of my end goal. I think, "You can't stop now." It's like, "what's the point of giving up if you want to be a doctor." It's just a work in progress and you can stop like half way. Even though it might seem hard. So, just take a break, go sleep on it, and maybe it will look better tomorrow - or in a week, or whatever. (Olivia S.)

6.11.2 Feeling Valued

Almost 25% of the participants indicated that one of factors that motivated them to persist was feeling valued in academics. Feeling a personal connection to professors and their peers created a connection that made them feel welcomed. Absence of a personal connection resulted in feeling of not belonging. The participants wanted to feel valued by others. Respect and connection with the academic community were important to them.

> I'm the kind of person who has to feel kind of [connected]... Not everyone in the classroom feels as though they belong, so I need to feel as if I have a personal connection with the professor or things like that because that motivates me to do better. But that's really not offered in college, and high school doesn't teach you that at all. So, it made me feel like I was really lacking in that. I feel like, other people knew that and I'm a lot less than other people in that aspect because I don't have that motivation when I don't have a connection to the professor. I wish that was taught to me more beforehand that I would feel like I don't belong and that I'm on my own in the classroom (Mary A.)

There was definitely an aspect of, “I don't want to disappoint the people” that I know which was huge. As soon as I figured out he [the professor] knew my name [laughter] I really did start doing a lot [of work] in my class, I mean I didn't do that poorly in my first exam. My second exam I got a true A and in my final exam I also got a true A. And arguably the material got more difficult. But, kind of as soon as there was a human aspect related to it, that's when I perked up….
So obviously with [the Douglass course] knowledge and power, I wanted to engage with the people that were around me, I knew that they wanted to engage with me, and obviously my mentor was very instrumental, I had a couple of instructors, but my instructors were very instrumental as well. Everybody was just supportive, so for me it's really that human aspect. (Jayne W.)

When I was feeling low and depressed, the Dean herself, like first time ever in my life I was sitting with somebody and talking about it, and she was just holding my hand and I didn’t feel like I was with any adult or somebody of power. It was like somebody who was willing to be there to help. That surprised me tremendously knowing that somebody was there who genuinely wanted to help you develop and definitely want you to nurture and grow as a - not only as an engineer / but also a student, but as a human being - and she kept on following up while I was studying abroad. She would send me emails which was really heart warming and that surprised me tremendously…the personal interactions were so important. They were able to make time for us and that was very helpful because even though we have a lot of faculty in the school of engineering and that I know that they try a

> lot, it's just hard to reach out because they're also doing their own research and a lot of things that are going on and things in the School of Engineering so they wouldn't focus on one individual. They couldn't focus on what our issues are that are beyond just academics. So, getting that help beyond academics was so centered within the Douglass community and I deeply appreciated it, tremendously. (Randy S.)

6.11.3 Peer Support

Students also cited that when the course work became difficult, they could rely on other women in the community to help or encourage them - they could just go out of their rooms and there was always someone around to encourage them and help them either with coursework or give emotional support. The students in the Reilly-Douglass Engineering Living-Learning Community also commented that they knew that their peers in the community as well as the staff and faculty were supportive and readily available to help.

> If I didn't have any support system, I probably would be by myself crying in the room somewhere, but they <peers in the Reilly Douglass Engineering Living-Learning Community> were there to help me with classes. And, it wasn't a one-way thing with them always helping me because I knew like some stuff like Science, like Chemistry and Physics, which I thought that was easier for me than it was them. So they would always come to me to help them. And, I would always help them. So it became a give and take. That was something that was okay and different. In high school I felt like people only came to me for school help and that was it. But this was the first time I felt like it was mutual - you gave

> me something and I'll give you something – so it wasn't like I felt used by people coming to me for only homework. No, I felt like they were a good support system when I was struggling (Olivia S.)

> Again, being part of the [Reilly-Douglass Engineering Living-Learning] community, you can talk to your friends and be like, "You're struggling too." It's comforting to be like we're all trying…Just having that willingness to go to a friend and know that they're struggling too. I'm not the only one. That is something that definitely makes you feel better about going through going through all these hardships. (Judy F.)

6.11.4 Faculty Support

While both male and female faculty members were important in encouraging the women to persist in engineering, participants emphasized that having an engineering woman faculty member inspired them or were a role model for them. Knowing that women who came before them "made it" was an inspiration that affected their own persistence in engineering. Women faculty members took time to speak with them and assured them, their ability to succeed.

> My professor for scientific research, I love her so much. She's such a good role model like someone that I can always just go to for guidance. I can ask her personal questions like what is it like get your graduate degree and have kids. I've always wondered that because I want to pursue a higher degree, but I'm like, "You need to get married, you need to have kids." How is that going to happen as a

woman while pursuing a higher degree, and you can ask for these things and it's not weird at all, which is great. (Penny M.)

Professor K., she was just so strict and driven, and motivated. Everybody was little afraid of her. It was in a good way, everybody really respected her. So it was cool to see a female was that powerful. We talked about it in our Douglass class - to actually see it here. What was really interesting was I think Dr. K. was the only female professor in our department until 2008. She was the first female professor in the school of engineering, but she was the only one in department until 2008, and then Dr. F. came. I only have three total, and then one female research professor, which is pretty wild because there's 33 professors in the department. I didn't realize it at all, that was pretty crazy. (Jayne W.)

There was this one woman professor that I had, she's the only lady I've seen who was one of my professors in a class. Everyone hated her, but I was just like, “you go girl.” More so than her, we had a professor for Physics teach us just one class as a substitute, and she was so much better than our actual physics teacher. I was just looking at her, I'm like, "You're teaching us, and it's just great." It was definitely something to look up to. Every time I see a women teach a class, it's very motivating, especially in engineering, it's like it's great just seeing somebody that you can relate to as a role model because I personally don't have anybody that I know who's an engineer in field who's a woman. (Penny M.)

6.11.5 Self-motivated

While both male and female faculty members were important in encouraging the women to persist in engineering, participants emphasized that by seeing successful women faculty members inspired them or became a role model for them. Knowing that women who came before them had even more barriers, but persisted and "made it" was an inspiration that affected their own persistence in engineering. Women faculty members took time to speak with them and assured them, their ability to succeed.

> Freshman year, I was in a chemistry lecture, I felt so overwhelmed and I wanted to start dropping classes, and I didn't know what to do. So, I sat in the back away from my friends and called my mom saying, "I can't do this." She gave me advice, "contact the deans of Douglass and meet with them." They gave me reassuring words. I had a lot of questions for them, and they still wanted to me stick with engineering because they always told me, "at the first, you're just getting your general courses out of the way, you can do this." Like having that reassurance from the deans, it was great for me, not only for me but, for my friends because they were going thought the same thing, too. I felt I could actually relate to my friends more because they actually thought dropping out of engineering, too. We empowered ourselves, and I remember one of the first days of college, we met with dean in the auditorium, who said, "Look to your left, look to your right. At end of the four years, the people next to you graduate with you." [laughter] So, the dean was uplifting. One of the Reilly-Douglass Engineering Living-Learning Community girls is like, "You're sitting next to me in that lecture, so, I'm going to make sure you graduate." Which is something I can think

about all the time because we were pushing ourselves, and it's very hard major, but we have to do it, it will pay off in the end. Because we're doing this to make our life better, to make everyone else's life better, and we want to make people proud of us. (Elena D.)

It was like the first few weeks, even a month or so into engineering I wanted to quit. I was like, "I don't want to go to college anymore" and then I was like, "Okay, realistically go to college and maybe I can be communications major." So, stepping into engineering was kind of like stepping on fire and it will shock you and you are not prepared for it. But, the more you step down on the fire the more you realize it's not fire at all it's just a warm floor. And then from there it will become a normal floor and then from there you'll be picking a part the floor and seeing how awesome it is. So, it started off terribly. I hated everything about it. I'm completely opposite now. I'm all for it, always advocating women in engineering and I love it. So, yes I thought about giving up engineering a lot of times. In Chemistry class we would write the energy. It was some graph with energy and you have to get over the energy hump in order to finish the reaction. We always say like that energy hump is engineering. I was like, "If I cannot get over that hump, then I'm not doing engineering. But, then again that shows you how much of a nerdy engineering student I am, the fact that I'm putting like how I feel into a graph. (Annie C.)

My freshman year second semester, I didn't do as well as I had done my first semester, and it was pretty discouraging, it was definitely discouraging. So for a while I was like, “Is this right for me.” What was interesting - and I only learned about this after doing [The Douglass Course] Knowledge and Power the second time as a mentor is, I guess females have a tendency to judge themselves harder than males do. I had plenty of friends around me who were getting straight Cs but they thought that was fine. Then when I got C+ in General Chemistry, I was like, “Oh my gosh. What I'm going to do. No graduate school is ever going to accept me,” kind of ideas like that. Then, what was really interesting, I was thinking, “I'd see how the first semester of sophomore year would go when I was actually in my major.” I was talking to the student who originally hosted me overnight before I came to college, and I was like, "How are the classes? How are they? Really, really hard?" She said, "They're hard, but you tend to do better in them as you go through your major." I asked, "But they get progressively harder, don't they?" She said, "Yeah, but then you also get better like you're better at the subject matter you have a better understanding of everything." And I thought that was absolutely wild, so I remember her saying that. I remember thinking, “let's see how my major is.” Then, I got an email from the Dean in Engineering who admitted me to the honors academy, and I was like, "Is he crazy, I got a C+ in General Chemistry, Why would he admit me to the honors academy." But it turns out there were a ton of kids who got Cs in General Chemistry. So, after I got that, I was like, “Maybe there's still hope, maybe other people still have hope in me.” I guess when I took more of a holistic approach in my education, then I start to feel like I can be in engineering and I can be valuable. (Jayne W.)

You know it's like you get this constant pressure of like, "well if am not doing well am might be better at other things, why not just do that." But, I've always had this thing in me to do harder things, challenging things in the area of science…it's like you struggle with it but then again you just have to follow your passion, you got to connect the dots later on no matter how you struggle. I was checking the grades, waiting for the grades to come out and I was like, I must have failed statistics like it was so hard at the final. But then it was hard generally. It was hard, period. I went to my professor's office. I wanted to see him but he didn't even acknowledge me. I don't even know; it was pretty bad. He was all into his research, but not teaching. It was bad. So, I was waiting for my grade and I saw a C, and I was like, wow, I actually passed. I was really happy, a C, wow. So I said, "well, I worked so hard for that thing, I feel like I want to stick to it." I worked so hard and I got a C, which like for other people is a C, but that C looks like really well earned. So I held onto it, and after that I've been close to about failing courses and still going and passed some of them. So I feel like my tenacity has grown from then, from the courses like at the beginning when I wasn't used to doing well. Now am used not doing well and keep going. So after I closed the page, I was so happy that I got that C and I was like, "I'll be an engineer, I'll graduate one day." I already know that the academics are hard and sometimes I don't do my best, I try my best but the best outcome is not the one that comes out of it, so I’ve become so resilient; like all the failures get thrown at me and I keep going. So I don’t feel like am going to switch, ever. (Cindy N.).

After the first semester I was like, “Okay, do you really want to do this or not?” Finals week is when you think to yourself - especially first semester finals week because you don't know how to study or anything and I did not get any sleep - I was like, "Do I want to go through hell each semester." But, I actually stayed because of Douglass. I talked to a few of my friends, I was like, "I don't know if I want do this." And they were like, "Do it, we will go through hell together." And that's what kept me and I'm like, "This is what I want to do, so just keep pushing at it." I love Douglass, I can talk about it for hours… Something that I want to do is break the stereotype, that's always a motivating factor for me. Every time I'm like, “I can't do this,” but then I think, “Wait, but that's what they all think that you can’t do this, but you have to prove them wrong.” Just breaking the stereotype is definitely another reason I persist. (Penny M).

I think being put through that constant stress of worrying about exams, worrying about all these projects, these papers, lab reports, really beats me down a little bit. I asked myself, “is this good for me, am I enjoying myself,” and even through all those annoying lab classes or test and finals, it really showed when I would get a good grade in one of these classes. A professor would come up to me and be like, "You really did a good job, I'm proud of you." That just go back into my head and I’d think, “I know this is difficult, I know a whole bunch of people are struggling as well, but you can do this. Even if you didn't get the highest grade, you still got that grade and you still learned a lot from that class." (Judy F.)

It takes a lot of commitment, a lot of self-discipline. You also have to have a good support and be able to find a way to... sort of like shake things off because times can get really stressful, so it's important that you don't get hung up on any bad thing that's happened. Say [for example that] you did bad on an exam, you need to keep working for the next exam and there's more classes, so you need to keep moving on. You also need to be able to adapt and take criticism and be able to cooperate with people. You need to be part of the team and work together and collaborate (Elena D.)

Honestly I just think of my parents. My dad is a doctor. So, I think, "Okay, he went through medical school." He's told me stories where like he didn't have much to eat because he was poor and had to go through residency and he stuck through it and he had two kids already at that point. So he did that in medical school and then my mom came from [another country]. She got a degree there and she had to come here and that degree doesn't count, so she had to start over, raise three kids on her… well my dad's always busy with work so like she's had to raise three kids, she did the whole at home mom thing and now she's doing college at home trying to get masters. So, they're really just an inspiration that they did all that for me and like they've sacrificed so much for me at this point that I can’t waste what they’ve done for me on just like not working my hardest in school so. (Sandy F.)

What matters is knowing that you did something to make a difference. I guess that's really what motivates me to do what I do, and that's why I chose biomedical engineering. To me anyway, I felt like it was one the most direct ways in all the engineering departments to really directly affect people. These are the morals, I had, and I still have in engineering. These are like even the small times I feel like I really just can't do it, it's too difficult, but you'll make a difference through this. (Mary A.)

I thought, “should I really go into engineering or should I not go into engineering.” What was really primarily holding me back was that I thought, “I can’t do it, that’s a lot of math, I only had pre calculus and I’m not that good.” But, I decided that I needed to do what I could. I can’t just say “no” because I think it’s just too challenging. I think, “just don’t just give up because of something like a set back,” there is something like perseverance. I think basically, “Just don’t lose sight of what you want.” (Ann G.)

Last semester I took 21 credits, I pledged Phi Sigma Ro, and I did research, and I ended up with a higher GPA than I did the first semester, which I was very surprised with. That was definitely something that even though I complained about it throughout the semester, once it was over, I was like, "This is great. If I

> can go through that hell of semester, I can go through anything." It's definitely motivational. So just going pushing your boundaries and pushing yourself, it shows you that you can accomplish anything you put your mind to. (Penny M.)

Another factor affecting persistence was the goal itself of becoming an engineer. The vision of the altruistic work of engineers was a driving force for students' persistence. Many students acknowledged that engineering classes were difficult giving them little free time. This hardship was outweighed by their desire to make the world a better place and improve people's lives. The students had a global perspective of how they could impact others. Some students wanted to become an engineer so that they could solve potable water in third world countries or improve cooling conditions in countries where too many people die from heat-related conditions. Ninety percent indicated that their motivation was to achieve innovations in the field to solve world problems, improve the lives of others, and become an innovative leader in the field.

> When people hear engineer, they think good things about engineers. I feel like they [engineers] can change the world and develop systems to make people's lives better and that's something I want to do (Elena D.)

> Civil Engineering is where I'll be able to give the most direct impact to people…I want to be able to go to third world countries and install water and that's like what Civil Engineers do. That's where I can accomplish my goal. People are in Engineering to make a lot of money and it's hard because it's not really my goal. (Sadie B.)

6.12 Difficulties

6.12.1 Barriers for Women in Engineering

The students provided information about experiences related to how they were treated by others - peers, faculty, and staff. These interactions evoked emotions that were perceived by the participants as either welcomed or unwelcomed. They spoke about their involvement in the Reilly-Douglass Engineering Living-Learning Community; experiences in the classroom with peers and professors; and their own feelings about their experiences in a variety of settings. There were times that they felt intimidated by professors or male students both in and out- of the classroom. They identified gender and racial discrimination as barriers to women in engineering. Participants talked about how they stayed motivated when others treated them differently or when things became difficult. Some of the discrimination was noted even before entering college.

6.12.2 Diversity Awareness and Racial Discrimination

Women in the Reilly-Douglass Engineering Living-Learning Community were well-aware of the lack of diversity and the lower numbers of underrepresented minority women in engineering particularly women of color. While Rutgers considers itself to be diverse, 32% of participants did not feel the environment as inclusive of them. Sixty-eight percent of the participants indicated that they were either directly or indirectly affected by racial discrimination.

> I would say in general I really noticed that there are only a few black engineering students - whether male or female. On my floor in the residence hall there is only one person who is black, I believe. I thought, “Oh, that has to be a bit discouraging to see.” (Ann G.)

One thing that I do realize that have been putting my mind to, there's not a lot of African American engineers, there's only one on our floor. It made me think that how she must feel. She's the only one, and I've barely seen any African-Americans in engineering, which was very surprising to me because I went to a very large diverse school. I've seen all different races all the time; it's very diverse. Within engineering, barely see any African-Americans, which puts me back and makes me think why. (Penny M.)

In fact, I don’t get to see Hispanics females. I may have only seen one that came from my school and she’s already like senior. I mean I love diversity, but sometimes you need people you know are like you here. I barely get to speak Spanish on daily basis. And when you’ve spoken that language until 12, sometimes you feel not as comfortable because you just want to laugh and make a joke in that language. So, sometimes in that sense I don’t see other people like me. It’s mostly males and some lone female Hispanics… I’m kind of like trying to defeat the stereotype and the statistics and that’s all I can do, for now. That’s what am trying to do now, to not be one more Hispanic who just sits around and doesn’t go to school and can’t speak the English language, and works at a factory like my own parents. These are horrible stereotypes. (Cindy N.)

I do think that there are interesting stereotypes that can easily be associated with a white female engineering student, especially because for example in my chemistry lab freshman year, my class was predominantly Asian and Indian students. There were five girls total. Four girls were Indian, and I was the fifth girl and I was white. What was interesting was the Teaching Assistant didn't know any of our names, but he knew that I was the only white girl in the class. He took off points whenever we would ask questions. If he doesn't remember the difference between four girls that look alike or they're in the same race, obviously I was different than them significantly because of my skin color, he can tell that, "it's definitely this girl that asked that question so I can deduct points." I've definitely seen aspects like that because I know he was keeping track of the points I lost. I definitely know that. I think there's other things associated with as well in terms of people thinking that you are more likely to go out and party for example because I'm white as opposed to Asian students. People don't think that Asian students party as much. (Jayne W.)

If you do mention that you're Indian, people think that you're smarter. And I'm like, "Not necessarily." Race doesn't determine how smart you are. (Penny M.)

There is a stigma that like if you are Asian you're smart; you'll be an Engineer or Doctor. (Annie C.)

6.12.3 Gender Discrimination

Twenty-four percent of the participants admitted that they were not aware of any differential treatment based on their gender. They felt comfortable with male students and professors. However, the majority of participants were subjected to derogatory remarks and discouragement from others, including their own family members.

> It was in high school when I was in this class and I was on the top of the class and there was a guy right beneath who was second in class. And, the professor said to the guy, “how do you let a girl beat you.” Back then I didn't know about feminism, I didn't know about equality and everything. So, I was like, “whatever, I beat you.” It doesn't matter. But, now I'm thinking it's horrible for someone to say that to me. I'm going to beat you, so it doesn't even matter if you're a boy or girl. So, that's just how it was. (Olivia S.)

> Actually, when I first started engineering school I came in as biomedical engineer and it was the influence of my parents saying that, “Oh women don’t do engineering!” Biomedical sounds like something that women might be in and that’s true you know there was a high population of women in biomedical engineering and that’s why I was there. But, I knew since day one that it was not for me. What helped me was that we had this introduction to the engineering class in the living-learning community and we had professors coming in talking to us about working with projects from every single engineering field. I knew that it was mechanic and aerospace and I am glad that I wasn’t stuck in that semester as well that was when I had to make the decision and it was without a doubt this is what I wanted to do. (Randy S.)

In college, the barriers included blatant gender discrimination from peers and faculty. There were times when the women felt intimidated, isolated, dismissed, and disrespected by male peers and professors. Students were aware of too few women students and faculty in engineering. Women students experienced a “chilly climate” in the classroom imposed by men and subjected to sexist comments from male professors and peers in the engineering program. Eight-one percent of the participants reported gender discrimination, felt excluded and their knowledge and value minimized by others.

> One time, I had a meeting a group meeting with my academic advisor, and it was the first time meeting him, and I was the only girl of a group of eight guys. I would try to say something but people cut me off. I was so angry. It was just like people some guys talking about this class is hard, I'm not doing well in this class. I thought, “That class is so easy, I got 80. I can run circles around you academically,” but no one let me speak and they're like, "This is so hard to get into." And, I'm over here thinking to myself, “I've been doing research since freshman year.” In that situation, no one's willing to listen to me. I was so upset everyone cut me off. It's like they were saying the things to themselves and they didn’t realize that I was there. That just irritated me a lot because I think that was the first time of my experience just someone completely running me off. I feel like it was because I'm a girl, because all the other guys got to speak. (Diana S.)

> Women are definitely treated differently. I remember in Statics 1, it was... maybe because the TA had a little a bit of a language issue, but I said the same answer

that a guy then said right after me. He [the T.A.] told me I was wrong, I was like, okay. He [the male student] said the same thing after me, and he [the T.A.] said he was right. Maybe it was a language issue. Maybe because he didn't understand me, but the T.A understood him [male student], which was very... that's like one thing I will never forget. My answer was the same exact thing - so you're treated a little bit differently, not severely, but a little bit. (Penny M.)

The tone of the professor might be a little bit different. Especially like in Matlab, he would get really frustrated. A lot of people are asking questions, he would get frustrated. And, It seemed if a girl was asking questions, he would get a little condescending. It seemed like he would be a little bit snippy. It's subtle differences you can pick up on [in the classroom].. I think that's a lot of it, it's like the subtle things that people do or how they are with the female students. Even like in class you can sit a little clusters of girls, it seems the girls are trying unintentionally or intentionally to stick together. But it's the subtle things you feel. (Erin O.)

Definitely felt like I'm not being heard. I feel like they [male professors and male students] just look at you [as a women in engineering] like you need to have things babied down to talk to you. That's not the case at all, I learned at the same pace as any other guy, if not faster. They [male professors and students] definitely look at you like you can't handle things. I'm strong enough to handle anything, don't think that just because I'm a woman you have to give me less work or think of me as a slower than a man who is in the same field. (Penny M.)

We would be in groups and that I would be the only woman. They [male engineering students] would not point at me and say that you get to be the leader. It's always being a guy chosen; it would always be guys always in front. That changed very quickly of course because there were brilliant woman in the Douglass program and within the school of engineering and they [male engineering students] need to see that. I don't blame them because of the way they were raised; because of the way the field itself is mainly men dominated. (Randy S.)

Even in our faculty we don't have a lot of woman, it is intimidating and they're trying their best. But, having that extra community whose going to give you the resources and tell you what is even available in the school of engineering - it helps tremendously and my non-Douglass friends didn't get that. (Randy S.)

I think that there is an expectation [from male engineering students] that women won't do as well …Most of my male classmates if I say, "this is what I got for an answer," they think that I'm wrong, so I'd let them think what they want. There is an expectation that if it comes down to it, I should be wrong and they should be right just because that's what make sense to people I guess…I feel that from my male classmates - that they kind of are surprised if a girl does better than them. (Sadie B.)

6.12.4 Sexism

In addition, the participants were subjected to outright sexist or derogatory comments. Some participants tried to ignore these comments but other students directly responded to the aggressor. Many of the women stated that they felt ignored or “not heard.”

> I deal with this pretty much every day in my engineering class where there's one student I know that's very high-achieving and very smart, who tried to get me wired up or say these things sometimes will be like, "Hey, if you punch me in the face, would you be okay with me punching you back in the face?" And I'll be like, "Yeah, sure that's fine" And he'll be like, "You know we're not supposed to punch a girl." And I'm like, "You can punch me in the face." So there were interactions like that, definitely. (Jayne W.)

> I can never… the ideas that are in my head, I can never just say them. It's so weird I don't know how to describe it. I don't know how to talk about it. I need to practice just making myself heard because a lot of times I have an idea, and I'll just be quiet and not say anything. Is this really beneficial when anything that you have to say, usually it's even somewhat correct, it would be beneficial to what you're talking about, what you're working on. Even if it's not correct in the end, at least you would've said it. I always keep certain things bottled up which I need to improve upon. (Penny M.)

> There was this guy freshman year. He thought maybe he could joke with this and he said to me, “maybe you would be a good domestic engineer.” I think right after he said that... one my other good friend he was sitting next to me and I think he got more offended for me than I did. I was like, “fine, whatever, you're just making a joke.” (Myrtle M.)

> I still think that some people do think that some of the women that get into engineering get in are admitted because they are trying to even up the gender gap, so the school drops the qualifications for women. So, I feel that some of the women who are part of Douglass have to put up the stronger side of them. We don’t mind if we don’t understand something [amongst ourselves], but sometimes for a women in class - especially because a professor sometimes ask if someone want to volunteer and go up the board to solve a question - I do see some certain girls who would want to prove themselves and go up there to solve the question. So, I feel like it is more like they are in need of approval. Kind of where as we are supposed to kind of support each other so we know that we are in this together and then there could be the mentality that people wouldn’t need to prove themselves. (Heidi Y.)

6.12.5 Self Confidence, Doubt, and Low Self-Efficacy

Seventy-six percent of the students reported feelings of self-doubt, low self-esteem, and low confidence in their abilities at some point. Feeling afraid of the coursework or doubt about their ability to succeed in engineering contributed to lack of confidence. There were times that the participants were stressed and frustrated, feeling that they should have performed better on an exam or project.

> But, I didn't understand how to do a lot of things. That was definitely a huge setback for me. Usually I'm able to figure things out. Like, I understand that all of this it gets you somewhere else. But, once I was in college it not like things were abstract, but it also wasn't exactly as linear as I expected to be. I felt very scared a lot of times because I didn't understand the work (Myrtle M.)

> And, there was always kind of the feeling that I was insignificant especially compared to everybody else. (Jayne W.)

> Were all engineers but in their [male students] minds they are just very confident. I remember in freshman year there's this one class that we are taking is ridiculously hard but even if we did well we always felt - and I speak for other female engineers as well - we felt very unconfident that we didn't do too well or we didn't do good enough, that this is it, the school that represents us as women engineers that this is why I shouldn't do engineer because we're just that bad. I mean as for men it would be more like, well one mistake you go on and can still keep on going…Being in class where I was the only girl, of course there were girls but very few especially in the aerospace field…I think that is something that is globally an issue that we are fixing. Of course it will get better. When I was taking summer class, I was the only girl and even though that I said that I was really good at public speaking, I was literally the only girl in the presentation. I

was brought up to the podium there I was standing there so nervous. I felt like I needed to prove myself in many ways as a woman and as a woman engineer. I think that was something that I constantly struggle with the first and second year. Like even being with my best friends in a study group where we would put up a question on board and I would wait until somebody stepped up first because I felt that they knew better, which is of course not the case. If it is the case then…but, it's not the case. It's [just] something that is mentally exhausting. (Randy S.)

My first semester was a little bit shaky because I took 17 credits. My brother said, it was fine, you can do it, but it was hard and it was a lot of me crying and [thinking] I can't do this. I never knew what a curve was because we didn't have that it's like an A is a 90 and you don't get it that's it. So my first exam I got like a 65 and I was thought I'm failing. How can I tell my mother… oh my god how do I call my mother [in my home country] and say I failed my first class? Then I found out that there is a curve and it was a "C" grade, but still… (Olivia S.)

I had an interview and they ask so many technical questions, I could've asked them so much better. I went back and I was like kicking myself, "Oh, I should have known this, I should've answered this better." They called me back saying that I got the offer without a second interview. I'm like, "They thought I was capable, they thought I actually could be a really good worker really valuable person in their team?" So sometimes I don't believe in myself as much as I should, or I don't see myself having those abilities that would be required of someone who was going for that position. Or even in my past internship when I found a problem was very vital to the researcher the problem we want to try to solve. I essentially solved it but I didn't really believe myself. I was like, “Maybe that little point maybe that's just a mistake.” That was the cause of the problem we were seeing in this material that was breaking or failing in a sense. I was like, “Wait, I'm only the intern, I'm not supposed to discover those thing right away.” I don't know if I had the background but I do. Having a degree from Rutgers is an amazing thing. I should feel capable like that. Sometimes I doubt myself and I don't think that I'm maybe as smart or maybe as capable as I think. So I think if I was able to believe myself more and be better with public speaking and force myself into situations that could really benefit me that might be uncomfortable such as going up and talking to a manager or presenting a problem. I think I would benefit a lot more if I was little more like, “Okay, you can do it I know you can…just go for it.” (Judy F.)

I’d never gotten a B grade in my life regardless of even thinking of getting a C. So, I got a C+ and I was like, “Oh my god what’s going on with me?” So that was difficult. (Sandy F.)

Sometimes I feel like maybe it just going to be a waste of my time, but can’t really hesitate anymore. If I am on a project with my peers I need to put my ideas out there. I need to show why this is a good idea. I just can’t hold it back and say,

> "Oh, this is not a good idea." I need more confidence and a little bit of the creativity, too. (Ann G.)

6.13 Perceptions of Other Engineering Students

6.13.1 Men in Engineering

Women reported that they felt one of the differences between engineering men and women is the perception that men feel entitled to be in engineering and women have to work harder to prove themselves as equal and qualified students. Further, women engineering students felt that male professors treated them differently - they are more patient with the women than the male students. For example, if a male faculty member raised his voice to a male student, he would soften his voice when speaking with the women students. The participants indicated that some of the male professors were "easier" on the women students than the male students. They did not like that and felt like they were being "babied" and viewed this treatment as disrespectful of women.

> Men engineering students: They look at you differently. I don't think that they look at you like you can't do the work, but they definitely baby things down for you a little bit. Even the professor actually, she'll give me lighter work to do, which I don't appreciate. (Penny M.)

> So one thing I know notice is that in my senior design group, you are assigned to a group in class. My professor had three groups and my group was all like five girls and the other groups are more men- like three guys. So, I feel like anytime

> everyone notice that I feel like he's more lenient on us. That is the first time I've ever seen that happen because I know like we definitely do more work that's no doubt. But, I felt like when they get screamed at it's intense. And with us the professor he's like, "oh, just do better next time, like how could you do that." I'm just here like, "Oh my god." But, that's the only time I would see that they treat them [mal students] differently from us. (Olivia S.)

> They're [male engineering students] different in a sense that they really feel entitled, "I am a man this is like engineering is a man's thing." I don't think they try hard enough, and then their drive lowers. When it comes to classes, I'm pretty serious about my schoolwork, I'm always doing my homework; then they [male engineering students] leave to last minute. If I ask one of my male friends if they did the homework they say, "No, why are you doing that so early." I'm like, "Because I want to get it done, I want to learn. Not waiting until an hour before it's due." Very different attitudes, in that sense. So they [male engineering students] definitely feel more entitled. I feel like since we're [women engineering students] a minority in the field, we feel we need to prove ourselves, and therefore we push ourselves more and go further. (Penny M.)

6.14 Inclusivity

While discrimination and differential treatment did occur, the participants noted that both male and female faculty members were inclusive and encouraging of them. Students spoke of both male and female faculty acting as mentors and encouraging their research, which was viewed as a support within the School of Engineering. Fifty-two percent of participants reported that male professors were supportive, inclusive, and encouraging. Although the women students appreciated the inclusivity and overt support of some male professors, they identified that women engineering faculty members were more supportive and encouraging at a much higher rate (95%). Women faculty were viewed as role models whose accomplishments and pioneering efforts in a male-dominated profession were admired and respected.

Interacting with women faculty from different disciplines in engineering (through the first year engineering explorations course), participants were inspired and saw themselves as future engineers. The women professors explained the engineering profession to the students in a small group environment and participants felt comfortable asking questions and learn about the different engineering disciplines through direct, hands-on projects. Women faculty made themselves available outside of the classroom to the students.

> Having a professor that was a woman engineer and especially meeting women professors from different departments in engineering was helpful. They told us about how their journey was and knowing that it was also difficult for them -- but you can see yourself in their place, you can see yourself as successful. The road is not the same down all the way and when the mechanical and aerospace professors came I think we had two-- and for me it was like, “This is what I want to do.” It sounded like the best deal for me, definitely. And she broke that down for me to the point where I decide that this is what I want to do. And, because they had interacted with us - they were very friendly, even outside of class - after when we

were done with the engineering explorations class, I was able to go to those professors and interact with them and ask them for any help that I needed. (Randy S.)

Professor Bu., I love her! She was amazing. She was telling me about her story and how shy she used to be or how she felt that she couldn't do much. She was so understanding of every other student and it didn't matter where you came from or what your story was, she was able to always help. I see her as a role model because when I met her I knew she was a very strong woman by the way she interacted with them. But when she told us about her story that's what really attracted me to her. (Randy S.)

The women engineering faculty exemplified the fact that you can be a really successful female engineer even in a field where there are more men. They're older than me, so even back in the day when it was harder and not as common for women to become engineers, they still did it and they have amazing careers. They've traveled all over the place, they've done amazing research, they've been to conferences, they give classes for graduate students, they have all this innovative research that's happening very real in the field of engineering. To have them as your professor, it's very humbling because you're like, "Wow this person has done so much in her life and still coming back to teach me about the field." To me, even when I go to their office hours, I can talk to them, and I even ask the couple of them to write those references for me. When they say they're more than

> happy to do that, you're nervous so ask someone to go out their way and write you a whole big thing. I would still be nervous to do that, but I knew that they would say yes, and that's a really good feeling to be like, “Hey, they know me well enough to write a whole recommendation letter for me.” Even if I'm struggling with any of classes, I know I can go to them, and they're willing to help and really want to see me grow… So I definitely see that is something I'm going to write them thank yous in the future if I ever see them, I'm going to thank them and be like, “You really inspired me continue with engineering and never stop learning.” (Judy F.)

6.15 Overall Outcomes for Women in Engineering

6.15.1 Empowered and Educated

One of the outcomes of enrolling in Douglass Residential College was gaining new perspectives and understanding that they can be agents of change. This was instilled through the coursework in the School of Engineering and at Douglass, through mentoring, participation in research, and in the co-curricular program at the Reilly-Douglass Engineering Living-Learning Community. After completing the Douglass course, students reported its profound impact on the way they perceived the world by helping them understand humanity, establish their identity, value diversity, and promote empowerment.

Douglass Residential College has a required course for all students called the Douglass Course: *Knowledge and Power, Issues in Women's Leadership*. This is as an undergraduate, introductory-level Women's and Gender Studies course focusing on the status of women in society, both locally and globally. Race, class, power and privilege are introduced from a gendered perspective. The course offers three academic credits through the Women's and Gender Studies Department in the Rutgers-New Brunswick School of Arts and Sciences. The course enrollment is capped at no more than 24 students to encourage discussions and engagement. The classroom itself is typically small in size and the chairs are set up in a circle, rather than theatre style. Enrollment is open to all Rutgers students, both men and women, but typically only women enroll and the majority are Douglass women from all majors. The majority of participants indicated that they were happy that the Douglass course was part of their experience. They rated it as a good course that was very different from their engineering courses.

> The Douglass course, Women and Power - Knowledge and Power - I loved it! Definitely, even after taking it as a minor class it is one of my favorite classes that I've ever taken because it gave me that extra open mind to other things. That life was bearable. It opened my mind to even understanding how women struggle within engineering. I am part of it [a women in engineering] but there's still so much that I didn't know about. And, it wasn't just useful for me but also for the other students who were there. They were able to look at us and understand where we were coming from and we were able to look at them and see where their struggles lie. That class was absolutely enlightening and I think that it encouraged people to have that extra humanity and the facts that you should know about because your life is not just numbers…I wanted to be around people because I want to learn --a lot. I want to learn in any way. I want to open my mind and there's still so much that I don't know so I loved being around athletes,

> and I loved being around artists, and I loved being around other qualities and people from different cultures. I was with some students who were going to do some engineering project. But, they were influencing those projects and those people who have lived their entire life the same way. I felt that you need to communicate why you want to bring a change. You can't just go to a place and say, "Hey! I want to tear apart your water system and create a new one." So, for me being around other nationalities and being around other students they were able to teach me a lot of things that I didn't know well. I love politics, public affairs, and all those things and that was mainly through Douglass because a lot of events that we had where it wasn't just engineering students so they would put us in random tables with other students and we would be able to interact with them and they would be interested with our learning and I would be interested in what they are learning. (Randy S.)

> It's like I've learned so much in that class, Douglass course. I am already a pretty open-minded person in stuff but that class makes it even better. You think you know all that but that class is a great place for debate, to learn new things, so it's just insanely great. I love that course because that's what you're supposed to do in college, like grow, learn more than you already know. (Cindy N.)

6.15.2 Accepted and Supported

The women in the Reilly-Douglass Engineering Living Learning community described the community as diverse and inclusive from the first day. Living with all women created a safe space where they supported each other and did not feel judged. Students socialized and studied together. They also connected on issues around engineering.

> I was feeling that they students in the living-learning community probably are not going to understand me or I'll have to explain more because I don't get the American accent. But, it was not like that. I did have to repeat things because they're like, "What are you saying?" But, they just kind of accepted me because I felt like the first couple weeks I was to myself, but would come into my room and be like, "Hello, we're going to dinner. Do you want to come?" And, I'm like, "Sure, why not!" I just like the fact that they didn't inquire into my life, but they tried to include me, which is something I don't think anyone has ever done for me. They included me in everything and with that I ended up with very, very good friends with them and it's just something I didn't think I was going to get anywhere else. (Olivia S.)

> So at point there are three girls dying one girls hair and you would not want to do that in front of a bunch of guys. So it is really just comfort and being yourself. I feel like being yourself is what is most important because you can develop into who you really are and kind of find yourself. It's funny because I know who I am, but it is important to be yourself while you kind of develop into who you really are. I think being a Douglass girl you have the space to do that. (Tina K.)

6.15.3 Promoted Student Retention

Many students stated that the community was a support network that helped them stay in the engineering major. They surmised that they would not have made it through the year without the emotional and practical support by the students in the Reilly-Douglass Engineering Living-Learning Community. Some students shared that when they felt like quitting or were discouraged by difficult courses and didn't think they could do engineering, the women in the community encouraged them and assured them that they would not let them quit. There was a lot of peer encouragement, bonding, and trust. Many stated that they didn't know what they would have done without the women in the community to support them when things got difficult.

> I know that the Reilly-Douglass Engineering Living-Learning community that I'm in, I'm very lucky because these students are not just engineering students but also very much interested in how they want to help the world change. They are also interested in politics and arts and my friends are doing all sorts of things. That's why I think that what makes them stands out because they're doing something very difficult but they are also being able to explore other things meanwhile. (Randy S.)

> Douglass is really important and women should know that if you are going to engineering, you do want to be in a community for support. Women who aren't in it don't know that they wish they were in it. They wish they were, but they don't know it because they've never had that feeling. Like I never knew I wanted a support system until I had one. I think that's really important to know. Douglass showed me the importance of having people who you look up to and who look up to you who are your peers. I don't have that anywhere else in school here other than with the girls. (Sadie B.)

Just mentioning Douglass is just another connection that I have with these girls, something I feel like it's an advantage that I have over everyone else who's not in Douglass…Freshman year, I was in a Chemistry lecture and I felt so overwhelmed. I wanted to start dropping classes, and I didn't know what to do, so I sat in the back away from my friends and called my mom saying, “I can't do this.” She gave me advice and contacted the deans of Douglass, so I could meet with them. They gave me reassuring words. I had a lot of questions for them, and they still wanted me to stick with engineering. They told me at first, “You're just getting your general courses out of the way.” They told me, “You can do this.” Just having that reassurance from the deans, it was great for me and for my friends, too, because they were going thought the same thing. I felt I can actually relate to my friends more, too, because they actually thought of dropping out of engineering, also. We empowered ourselves, and I remember one of the first days of college, we met with the Dean who said, "Look to your left, look to your right. At end of the four years, the people next to you are who will graduate with you [laughter].” So the Dean was uplifting. One of the Reilly-Douglass Engineering Living-Learning Community girls is like, "You're sitting next to me in that lecture, so I'm going to make sure you graduate." Which is something I can think about all the time because we were pushing ourselves and we’re pushing each other. It's a very hard major, but we have to do it, it will pay off in the end. Because we're doing this to make our lives better, to make everyone else's life better, and we want to make people proud of us. (Elena D.)

So the community helped me realize that you should be cheering for other people, you should want other people to do well…I did feel insecure as an engineer student and the community definitely helped because you had a bunch of people who weren't judging you based on your SAT's scores, and weren't judging you based on what your math score was and people in the Douglass community did not care if you were an honors student. I definitely felt by the end of the year a lot smarter, and I surround myself with good support of people, and then I tried to be a part of engineering honors academy and they let me in at the freshman year. I will definitely say the community gave me confidence. It definitely help build up my confidence, especially because people in the community weren't necessarily like me. They were really happy that they were doing engineering, they were like, "this is my life's calling let's do it." And being surrounded by people like that really helped me to realize it's okay we can do this, and realize that my insecurity in a lot of ways were unwarranted. (Jayne W.)

The girls in the community helped me to open up because they knew when I had a problem. They let me know that they were always there for me and helped me in an emotional-mental way, which affected me a lot. I guess in middle school or high school I was more guarded. Having them [the students in the Reilly-Douglass Engineering Living-Learning Community] and having them to talk to -- just being direct with me was very life-changing for me. I don't think I could've gotten through engineering without having those people in my life. I remember

> last semester I had senior design and would come home like 3:00am I always knew my friends would be back in the apartment waiting for me. They were always there to cheer me up. If I had a rough day in lab, they would cheer me up, taking me out or something. That's something that I really valued having them there…I feel like Douglass is just something that just changed my life. One of those unexpected experiences that I never saw coming. It's something that I wouldn't take back. If my brother was a woman, I would tell him to do Douglass [chuckle]. But, I just hope that he finds his own group of people that he can have a connection with like I had in Douglass (Elena D.)

6.16 Feedback and Advice

6.16.1 Most important aspects of the Living-Learning Community

The women in the Reilly-Douglass Engineering Living-Learning Community identified supports that helped them in college. , They most frequently cited that the community provided: friendships, common experiences as women in engineering, and a network of support that helped to build their confidence. The participants identified these as important factors in helping them stay in the engineering major. When faced with difficulties the social network of the community helped them build resiliency and confidence.

> We see each other fail, we see each other succeed and we were there for each other. That was the most important part, I think. That relationship is much more different than being with a friend that was not there to see us, to see us go through

it all. We can talk about it, but it’s just so different we you see it; supporting the girls while crying, or late at night awake laughing, or just doing anything, or learning. We have that special bond because we knew that this was going to be hard, it’s going to be a hard journey but were going to stick together. (Randy S.)

I got a lot of confidence from the community as well because like I said, I did feel like I was more insignificant as a student. So, I did feel unsecure as an engineer student and the community definitely helped with that because you had a bunch of people who weren’t judging based on your SAT's scores, and weren't judging you based on what your math score was a little bit lower, or you're not an honor student. I definitely felt by the end of the year a lot smarter, and I surround myself with good support of people, and then I tried to be a part of engineering honors academy and they let me in at the freshman year. I will definitely say the community gave me a ton of confidence. It definitely help build up my confidence; especially because people in the community weren't necessarily like me, they weren’t insecure. A lot of people were really happy that they were doing engineering, they were like, “this is my life's calling let's do it.” And, being surrounded by people like that in addition to other people that questioned the engineering major and felt, "I don't know how I feel about this." It really helped get to that level and especially having the year above us that had already gone through it, really helped me to realize it's okay we can do this, and realize that my insecurity is a lot of ways were unwarranted. (Jayne W.)

The most important aspect of the Reilly-Douglass Engineering Living-Learning Community was support. I wouldn't be in engineering right now if I didn't have the support. The support of my fellow girls that lived around me. Douglass gave me a mentor, so she helps me pick my major as well, [the staff in the Douglass Project]. Everyone in Douglass, they're very supportive. And, just having that support even a little bit, it keeps you going, it keeps you stuck with it. Girls help you through anything. Whenever I'm struggling, even just a little bit of support goes along way. (Penny M.)

I felt like having this small group in engineering in general helped me find out who I felt comfortable with, and my relationships with the students in the Reilly-Douglass Engineering Living-Learning Community developed over the years. It's important to be with people that you feel comfortable with. They give you strength and they give you support that you need. When you're in a right mental place and are supported socially, it will help you with the academics because you need to have a good mind when you go into college and go into new experiences. And, a good support will help you when you fall. (Elena D.)

Even if you weren't super close, you're still there looking out for each other. (Erin O.)

Really, like the community itself. Knowing that you have a group of people that you can reach out if you need help. Knowing that all of you are struggling together. Engineers that struggle together stay together; it's a fact. Just knowing that you go to all your first classes and there are 300 people, knowing you're able to come back and even those girls that aren't in a particular class are also studying the same thing, it really is a very helpful thing freshman year. Knowing all the students are taking the same classes. So being able to go across the hall and they are also doing Calculus I. So, starting to learn how to work as a team, knowing that you do have that buffer right there, like if you watch someone who's very shy, knowing that you do have people right there that are willing to work with you even if they don't fully know you yet. If you are more outgoing you can still reach out more. So the community helps you when you need it... I did have so many times when I did question myself about my major, about engineering like looking out like seeing all these amazing people working, you don't want to leave them, they do become like a family. So that's why it’s such a big thing -- why it's so important to have the Reilly-Douglass Engineering Living–Learning Community. (Myrtle M.)

It's been really awesome. It's really a wonderful group of girls. It is a really nice supportive community. I guess like I never knew how much I would want a supportive community until I had one, until I was here and I feel like girls who aren't in Douglass can really use that. Like if you say, “let's get a 4.0 next semester,” they're like, “yeah let's study together.” versus someone who would say fail next semester and they laugh because they don't think that you can do it. That's what I found in Douglass is like a bunch of really motivated girls and very supportive. So, if I would say, “Let's get 4.0,” and then it would just be like a

> thing you actually shoot for it. If you work together it's a lot easier. And also like living on the same floor you can yell down the hallway for help and someone helps you. It's really nice to have all your closest friends next door to you…I have a really good friend of mine who actually lives in the same residence hall, is not in Douglass and she definitely did not have the same support, definitely not. She always studied by herself, made a bad choice also because she didn't have that group to be with. She was friends' only with a lot of guys. That was okay but she said it doesn't give her that kind of support. And she was pretty passive. Like she didn't aim to be shooting for the stars and I don't know if that was a result of not being around people. Douglass is kind of unique, you know. People always remind you that you are awesome. It's important because you don't get that from anyone else. (Sadie B.)

Many of the students noted that support was not only peer-to-peer, but the living-learning community was structured with intentional and layered access to deans, faculty and staff. This created an environment where women had a multi-faceted community of support. The social network provided needed support for retention. And, the students valued the connections to other networks that the community facilitated. Their involvement in the Reilly-Douglass Engineering Living-Learning Community created connections to other networks that created bridges to resources and people. Social capital, with the creation of social networks is grounded in reciprocity, trust and mutual help. The Reilly-Douglass Engineering Living-Learning Community exemplified a social network that formed organically. The awareness of the inherent benefits of the living-learning community was clearly and repeatedly acknowledged and articulated by the women in the Reilly-Douglass Engineering Living-Learning Community.

> You learn about resources, you could build a bridge with other students for other resources. And you're just like keeping them in the loops and understanding and become aware of how important it is to keep yourself in the loop and not just teasing yourself and just say hi every now and then. It's like being part and being engaged in the community, thinking about a lot of the resources. It's helping me because that's what they train you for; to be a helper for others. (Cindy N.)

> The strength is that you have the support network. A lot of the time when something is going on, such as one of the girls was sick and the whole community knew she was sick and we all would get her whatever she needed. And, even now we have group chats. (Tina K.)

> This was the first time I felt like it was mutual like we had, you gave me something I give you something, so it wasn't like I felt used by them coming to me for only homework… And I felt like they were good support system when I was struggling (Olivia S.)

> The community helped me realize I really shouldn't comparing myself against people that much because I can be very damaging, and it can not only be damaging to myself, but also to potential friendship that I can have with other people. So the community helped me realize that you should be cheering for other people, you

should want other people to do well….I think that gave me a ton of confidence because she was looking at me and she was confident enough to tell me it's going to be okay. It was somebody with a more clear perspective of the situation. I say the same way to her because she would say, "I really didn't do well in Calculus." And I'd be like, "It's going to be okay, your grade are going to get better once you're in Electrical Engineering, we've gone over this." We can look at everybody's situation with clarity but our own. So being in a community absolutely took my confidence to a different level because at least there was one another person at any given time who was believing in me in what I can accomplish, and that was absolutely huge because I also believed in her in what she could accomplish. (Jayne W.)

The girls in the community were always there for me. I remember when I had Organic Chemistry and I was always in the library. I'd come back home and there were cookies on my table. I was like, "thank you" and you're about to tear up because, oh my god cookies after a long day at the library. And, they knew that I was super busy and that I didn't have enough sleep and they would just do things for me and I was just like, "Thank you I needed that," and....so it was a good experience overall. (Olivia S.)

I considered dropping out of engineering after the first semester. I ended up with 3.1. That was not the best. It's okay. It's good. It was above 3.0. I personally wasn't proud of that, so I was like, "Okay, do you really want to do this, do I really not?" Finals week is when you think that to yourself especially first semester finals week because you don't know how to study or anything. I did not get any sleep, I was like, “Do I want to go through hell each semester." I actually stayed because of Douglass. I talked to a few of my friends, I was like, "I don't know if want do this." And they were like, "Do it, we will go through hell together." And that's what kept me [in engineering] and then I'm like, "This is what I want do, so just keep pushing at it." I love Douglass. I can talk about it for hours [laughter] (Penny M.)

6.16.2 Perceived Weaknesses of the Engineering Community

The participants identified both strengths and weaknesses of the Reilly-Douglass Engineering Living-Learning Community. One of the weaknesses was the geographical location of the engineering community in relation to the main Douglass Campus. The physical distance is approximately five miles. Therefore, the distance is too far to walk and walking options are either a highway or through the city downtown and urban neighborhoods. There is a bus transport system between campuses, which is free, but takes too much waiting time and the bus stop is a far walking distance from the residence hall on the Busch Campus. These were identified as deterrents to attending events, lectures, and other programs on the Douglass Campus.

We really don`t feel that we are part of Douglass at all because it`s just, it`s really hard to get to the main Douglass campus, especially because the only stop to get to Douglass is in ARCH and that is such a long walk and the bus, they don`t come often and it`s time consuming and when we get to the Douglass campus, there really is no place for us to go so except like, sometimes, I go to the Douglass

> Project building. The Douglass Project is a really nice hang out place but other than that, I don`t see a reason to go to the Douglass campus. So I just really -we feel really - disconnected from the larger Douglass [Residential College]. The only few times I went to the Douglass campus was when there was an actual event and my friend had a car and she wanted to go so that`s the only time I would go. So other than that sometimes when there`s an event, I`m in class or I have a long day and I`m not going. So, I feel like this geographical barrier kind of played a role in it but other than that, yeah, I don`t really see any weakness. (Heidi Y.)

6.16.3 Advice

Eighty-six of the participants offered positive feedback on the Reilly-Douglass Engineering Living-Learning Community focusing on how the community supportive them to stay in engineering and how they benefitted from the structure of the living-learning community. They also gave suggestions for improvements.

6.16.4 Keep the Community

Participants pled for the Douglas Administration to keep the community going for future incoming students. They identified the community as an important part of the student's academic and social life throughout their undergraduate education. The students credited the support of their peers in the community, the structure of mentoring, resources, and student access to them; and the mentorship by the staff and faculty in the School of Engineering and in Douglass for helping them to persist and succeed in the major.

I would say keep it going. Do not stop because many people has benefited from this and there's no reason for you to stop because I felt like it's such a big part of my four years here. Like you take that out I probably wouldn't have had anything. So just continue that and just keep doing…The best part is the relationship I had with all the other women like both lower class and upper class. (Olivia S.)

Keep doing it because it’s not easy to do something, and you know what; with a lot of things in life you don’t get instant gratification. Once you have reached the part where you’re able to help people, to take their first step to actually help people, you’re like doubting, “Is it really going to make an impact? Or is it really worth it or are there any other ways to help people.” But then again you do it because of a reason, and that reason is like you do it because you know these are the people who need it, even if it was a small program, still it will make an impact but especially if the program is big, it really has changed the lives of people. Like am pretty sure that there’s more than just me, there’s more getting this out there, but especially me; it’s made a difference for me and it’s something that if you want to help people then do it right because people like me will have been helped. I want to go back after I make it out of the system, and go back and help the system to even be better than I left it, better than I found it. So it’s like a chain, it’s like you’re passing down this torch. You’re not just giving; you know granting people opportunities for the sake of it, you have to drop things to be able to pick them up later. You have to put a seed down and later on come pick up the

> flower, so that's pretty much what's happening here, like you keep doing what you're doing because it's making the difference, really. (Cindy N.)

6.16.5 Suggestions for Improvement

The benefits of the community were substantiated and valued by the participants. While the students were grateful for the community and its supports, there was also advice on ways to improve the Reilly-Douglass Engineering Living-Learning Community. Eighty percent of the participants indicated there should be more of an effort to connect the different cohorts to each other, current Reilly-Douglass Engineering Living-Learning Community students to alumnae that were part of the community, those who recently graduated and women alumnae that had previously graduated from the School of Engineering. A further suggestion for improvement was to provide events and programs for engineers on the Douglass Campus so that they would have more reasons to go to the Douglass Campus and create opportunities to network with other Douglass women who are not in the engineering major. There was also a desire for a stronger, more intentional peer-to-peer, graduate student-to-Reilly-Douglass Engineering Living-Learning Community student (all cohorts), and staff/faculty –to-student mentoring program for all cohorts. The students indicated that they had different questions and needs during each of the years in college and wanted a mentor throughout all four years.

> I think we should work on like connecting the different classes or different years together. I know they have like a mentoring problem program but I think it's...I mean they do try to like bring all the different years together I think it's really mostly on the student who want to try to like go and reach out and all that. (Harriet D.)

One of the things that I wished that the Douglass community would do for all years is I feel like each year we should all still get a mentor. I feel like they kind of broke us off too early because there are still some things that am still trying to figure out and I would appreciate it if I had received help. It would also have been helpful if we were paired up with people in our own major. I wish I knew a real ECE upper classman really well who was also an adult. I feel like the mentorship was my bigger complaint. I feel like there are still a lot of upper classes that I never met and I actually met a lot of them when I became an ambassador and a few of the graduate this year. And I wish that I knew them earlier and I could have asked them some questions and some of the things that they went through. But, other than that, it is okay. (Heidi Y.)

I would love to spend more with the community. I think it would be really helpful if the graduate mentors could do a better job of targeting the older students to get more involved with the younger students. Because I met so many people for the first time at the dinner for the current freshman group or the rising sophomore group. So then you really get to wonder are they getting the same as the community feel that we were getting, which they're definitely not to say it's a good thing or a bad thing. Because at the time we really were focused on interacting with the older girls, and I think there's less of the focus on the older girls or interactions between the different levels and more focus on interactions within the levels. That can also be a scheduling thing because it's much more difficult to schedule everybody when they're involved in so many different things if we're older or from different places looking on different campuses, living in different buildings, but I do think it's an interesting aspects that hasn't really been well developed within the program is what are the true roles of the older girls. (Jayne W.)

Have more events together and make it more fun events, like the New York trip in my freshman year. That was really fun, but it didn't happen again, and there's no other event we could all go together. (Renee T.)

Try to have more activities or events with other Douglass students that are doing Engineering. Like really, in the Douglass program, I don't know many girls outside of the Douglass Engineering group. (Jenny P.)

Motivate DELLC girls to get involved more. As well as to probably have different programs that are offered and advertised more for DELLC students. Because, I know sometimes there'd be a banner or something, and I'd be like, "Oh I never heard about." It was on Facebook page, and I'd be like, "Oh!" So if there are more opportunities for people to hear about that, that'd be nice. Maybe alumni to help in that aspect by telling students like, "Oh you're not doing well right now, but I went through the same thing and here I am now." That would help too. (Mary A.)

Do a lot more to introduce the freshman to the upper classmen and connect the different grades. Also, do a lot more to connect the freshman to each other. Throwing them together, it's great and awesome; but, at the same time, if you want to make more of a community, you need to do a couple more events to show them all the potential that they can have here. Help them to get to know each other a little bit, play some games, and have some movie nights. That of course could be put on the role of the upper classmen, but you need to have a good start like initiating that. Also figure out some way to get DELLC more involved with Douglass itself if that means maybe having the Douglass governing board having a DELLC member that can be a bridge builder. Just do something to try to get them more involved because at Douglass there are so many opportunities. But, living on Busch you don't see them and not being involved in the Douglass community physically, you do miss it a lot. (Myrtle M.)

More programs. Definitely do a little bit more activities that would bring us all together as a group besides the Explorations class and just living together. I remember there was a New York City trip. Definitely, something at least once per semester not like all the time. Just once a semester with something that's definitely required for all the girls to attend. I feel like it would bring us closer. (Penny M.)

Create more bridges connecting the engineering students to the Douglass College entirely. Yes we have a huge support in the School of Engineering for Douglass

> students, but connecting or being able to interact I want to interact with students who are in Douglass College who want to do so much. Because, there are a lot of brilliant woman in Douglass. I want to be able to learn from them. I want to be able to offer them so much but we can't do that if we don't create those bridges and I mean like literal bridges, which Douglass should probably have directly. I think more ways to interact with each other. (Tina K.)

6.17 Summary

The qualitative data analysis supports the quantitative data that the Reilly-Douglass Engineering Living-Learning Community affected the recruitment, experiences, and retention of women in engineering at Rutgers – New Brunswick. Through the analyses of data that were collected via the semi-structured individual interviews, the impact and outcomes of participation in the women-only engineering living-learning community emerged. Outcomes included social, emotional, academic, and professional impacts on the participants. Factors that affected participants' interest in engineering and their motivation to persist were explored via the interviews.

6.17.1 Demographic Data

The 21 women interviewed represented each of the initial four cohorts in the R-DELLC with five students from each level, first year through senior, included plus one student who left college. The participants were diverse in race/ethnicity. In total, more women in R-DELLC did not identify as White. Within R-DELLC the majority of women identified as Asian/Pacific Islander. Black/African American women in R-DELLC represented a higher proportion of students than were proportionately represented in the two comparison groups. It is interesting to note that while women who identified as Black/African American they were not a majority in R-DELLC group, the proportion of nine percent of the R-DELLC group was a higher percentage of Black/African American students than were represented in all men and all other women (not in R-DELLC) in the School of Engineering.

6.17.2 Motivation for Engineering at Rutgers

Women in R-DELLC identified four main reasons for choosing a major in engineering. Primarily they cited being "good" in math or science. The students indicated that they had been able to participate in math or science extra-curricular activities from elementary school through high school that sparked an interest in continuing related activities. Many had a family member or close family friend who was an engineer so that they were familiar with what an engineer does and were encouraged to be an engineer. Finally, in addition to any other forms of inspiration for engineering, high school teachers were critical in encouraging a major in engineering – especially math, science, or technology teachers.

The majority of students interviewed indicated that they chose Rutgers University to study engineering because of Rutgers good reputation, proximity their home, and reasonable tuition cost. Many students also indicated that a family member or friend had attended Rutgers and highly encouraged them. Some students who chose to enroll in R-DELLC had chosen Rutgers because of the availability of the women-only engineering community.

Students in the community indicated that they expected the R-DELLC community to make their initial transition into Rutgers easier. They anticipated being surrounded by women would be a source of support, understanding, and friendship. The women in R-DELLC indicated that they wanted a smaller community to identify with within engineering and within the larger Rutgers community. However, they appreciated that they had access to all that Rutgers has to offer.

Consistent with the creation of social capital theory and the building of social networks, the inherent benefits for and within a social group function to provide connections and positive outcomes for the members of a network. Friendships, information, resources, and assistance are some of the components and benefits of networks. These factors were also described by the students in Reilly-DELLC and consistently matched the benefits that social networks provide as underlying factors of communities.

6.18 Experiences and Outcomes

6.18.1 Student Engagement in Curricular and Co-Curricular Activities

Students who were interviewed appreciated the many opportunities offered at Rutgers. Most students were involved in a variety of activities. Ninety percent of students interviewed were members of engineering-related clubs or organizations. Membership in the Society of Women Engineers was a popular organization in which many women were engaged. Phi Sigma Rho, the sorority for engineering women was also popular. Student organizations for minority students in engineering were found to be a social support for some R-DELLC students. More than half of the R-DELLC women interviewed were active in non- engineering activities. This included such as sports/regular exercise, performing arts, social justice groups, comedy, faith-based student organizations, cultural clubs, or being a mentor.

Douglass students also had access to paid research opportunities through special funding available through the Douglass Project for women in STEM. Many of the women in the engineering community were connected to faculty in research labs where they worked alongside faculty and created posters of their research which they presented at an annual college symposium. Research is one of the high impact practices identified in higher education that leads to better retention. By helping students engage in research related to engineering, their professional and career development was enhanced and the practical application of academics was facilitated.

Consistent with Astin's theory of student engagement and high impact practices in higher education, students who become involved in college activities outside of academics are more likely to be retained in college. Since R-DELLC students were involved both in engineering and non-engineering extra-curricular activities, research, and mentoring these connections may have contributed to experiences that validated their interests, engaged them in a variety of networks, and fostered identity.

6.18.2 Difficulties

While the R-DELLC students revealed many positive supports that were encouraging and helpful to them, they also revealed difficulties within and outside of the classroom. They experienced racial discrimination, sexism, exclusion by men, and differential treatment that they felt was due to being a minority in engineering either due to their gender and/or their race. Male peers made sexist comments, were dismissive of the women's knowledge and contributions, excluded the women from group activities, and were demeaning. This occurred in and out of the classroom.

Eighty-two percent (82%) of the Reilly-DELLC women interviewed indicated that they experienced some form of sexism, discrimination, exclusion or micro-aggressions from male peers and faculty. Some male professors were perceived as treating women differentially. For example, the women in R-DELLC felt that some male teachers tried to "baby" them while holding the male students to a different standard. Many of the women were aware that some male professors spoke more harshly to the male students than to the women students. Some male teachers and male peers were reported to exclude women in the classroom, perpetuating the "chilly classroom climate," identified by Hall & Sandler (1982). A chilly climate in the classroom perpetuates differential treatment, sexism, and exclusions, which often force women out of a major because they don't feel that they are valued. Some women begin to feel that they might not belong in the major because they begin to question their academic qualifications and whether or not they belong in that environment.

6.18.3 Supports Contributing to Engineering Retention

Interviewees revealed several factors that contributed to persistence in engineering. While there were difficulties that the women attributed to their gender, they also reported important supports from male and female peers and professors. Students did report that they felt included in the classroom by most male and female professors and that while some men discriminated against them, some other men were helpful, encouraging, and respectful. The Reilly-DELLC women were sometimes asked to join co-educational study groups and felt welcomed in extra-curricular group activities. Peer and staff mentoring, connection to other networks, resources and opportunities that were built into the R-DELLC program, personal attention from women faculty and staff, professional development, corporate networking, and special field trips were benefits of the women-only living-learning community which students felt were supportive and encouraging.

The support of peers, particularly those in the R-DELLC community were central to staying in engineering. Consistent with the underlying function of a social network, the members of the network provided social, emotional and practical support to each other. In the case of the R-DELLC community, the encouraging words between R-DELLC members was identified as one of the factors that was the most important in helping them get through the toughest of times. The opportunity to live in close proximity facility the R-DELLC students studying together, going to class and meals together, helping each other with homework, being supportive of each other during difficult times, making food for a community member to make them feel valued, and sharing information and resources. These were some of the components that enabled this community to function as a supportive social network. As a result, trust developed between members and close friendships developed. Group members made ‘pacts’ that no one would be left behind – no one would fail. The inherent trust and reciprocity are consistent with social networks and based on the theory of social capital, the creation and continuation of trust and help within the network is important for the success of the individual and the group.

Also consistent with social networks and social capital theory, students in the Reilly-Douglass Engineering Living-Learning Community gained access to resources and network that they may not have otherwise engaged with if not for the R-DELLC network.

This included direct access to women who were staff members and faculty both in Douglass and the School of Engineering who provided needed mentoring and advising, encouragement, and help with logistical issues, when needed. The staff in the School of Engineering and at Douglass created personal connections with the students. And, in particular, faculty members became mentors. Students indicated that the few women faculty members were inspirational and provided encouragement to persist in the field.

The Douglass course was another component of the community that helped its members to feel empowered and valued. This was also an opportunity to meet non-engineering women and interact with Douglass women who were not in the R-DELLC community. Many identified this course as critical to their education.

6.18.4 Advice

R-DELLC students regretted that they did not have more interaction with Douglass women who were not in engineering. They also wanted more opportunities to meet and interact with R-DELLC students of different years. Students in R-DELLC pleaded for the administration to continue the community. They identified the living-learning community as an important factor for their own retention. The overall support and inherent resources of the network is consistent with the benefits identified for communities based on social networks as created through social capital. The supportive community encouraged persistence. Students' motivation to continue was reinforced by peers, faculty and staff through repeated encouragement. This helped students to remain engaged, continue to build self-esteem, and have the reinforcement to persist.

One issue that consistently emerged during the interviews was the concept of resiliency. Students did not directly say the word "resiliency." Rather, they described and alluded to having to learn how to build flexibility in accepting failure and difficulties in order to persist. For example, when asked the question, “What made you stick with it when things became difficult,” or a related question, “Did there come a time when you wanted to quit,” students gave multiple answers to the questions, but one consistent answer was that they had to learn that it was okay to fail. They had previously strived for grades of an “A” or “B” and had earned high grades in high school in what were considered difficult classes such as advanced placement or honors classes. So when they entered college and began to receive low grades, sometimes for the first time ever, the women perceived the low grades as evidence that they did not belong in engineering or that they could not do the work. That was because they simply were not used to getting lower grades, they had not had that experience previously in their academic career.

This perceived failure, which was actually not failure, led the women students to thoughts that they were academically underprepared or maybe couldn’t do the work for engineering classes. It was not until they gained the self-awareness and acceptance that they could earn a grade of “C” or could even fail some tests, and still be an engineer that they built the resiliency needed to accept grades that were lower than they were used to earning. It was a combination of the encouragement of their peers in the community, the support of women staff and faculty, and coming to their own understanding that failing was alright that they then realized that they would still achieve their goal. This self-acquired resiliency and acceptance helped the women to persist. Some participants even commented that the male students would fail and just keep going. At first, some of the women students didn’t understand how failure could enable a student to still be good enough to be in engineering. Once they gained an understanding of grading curves, self-acceptance of perceived “failure,” and built resiliency, then they persisted despite any setbacks.

In sum, the theories of social networks, social capital, student involvement, and expectancy-value-motivation each framed and helped explain the dynamics and outcomes identified in this study. The theories complemented each other. The living-learning community exemplified the characteristics of a social network, including trust and reciprocity. Social capital was inherent in the community with opportunities, information, and resources available to the members of the network (living-learning community). Connections to other networks enabled the sharing of information within and between individuals and the group, which further built capital and expanded opportunities. By virtue of the participants’ involvement in the living-learning community, they were engaged in social, academic, and research activities. Many of the women in the Reilly-Douglass Living-Learning Community joined clubs, organizations, and engaged in sports.

Astin’s theory of student involvement is based on the research that students who get involved in college, engage with others, and feel a connection and identity with the school have a higher retention rate. The living-learning community, itself, provided the participants with an immediate identity as a “Douglass Woman.” The interviews revealed that the R-DELLC students embraced that identity and other students referred to them as the “Douglass girls” on the “Douglass floor.”

And, finally, Eccles Expectancy-Value-Motivation theory overlaid the other frameworks. Persistency is an underlying concept of Eccles model. The data in this study showed that students persisted; but, in seeking to understand *why* students persisted, the interviews revealed that the benefits of the living-learning community functioned to meet students' expectations of support from women around them and from the college. This expectation was met. Students came into college with the expectation that the community would provide support because they also had the expectation that the academics would be difficult, demanding, and potentially isolating. The living-learning community provided a built-in support system and instant friendships, which evolved into trusted members of their immediate circle. Students stated that they would not have made it without the women in the community and that they trusted them with their lives. Also, each participant had the expectation that they could and would become an engineer. The support of the community, from many facets including mentoring, programs, peer/staff/faculty support, women role models, research, and living in close proximity all worked together to continuously reinforce that they could and would become an engineer.

With those expectations, the value of pursuing the degree - despite any difficulties, failures, and frustrations – helped to build a resiliency and focus to persist. Other factors could have affected persistence such as family supports, inner drive, and aspects that were not explored in this study which may have affected persistence. The theory indicates that when the value of the task outweighs the difficulties, persistence is more likely. When expectancies and task value remain strong, then motivation can remain high.

Therefore, the social network (community), which inherently offered and built social capital helped to facilitate student engagement. In turn, student expectancies could be met which fostered resiliency and helped to keep students motivated to persist. Ultimately, the value of becoming an engineer remained valuable. The ultimate goal of becoming an engineer was met and the data in this study supported that women in the community had the highest retention rate and the highest academic achievement, despite entering college with lower academic achievement.

Chapter 7: Discussion and recommendations

7.1 Background

Women have been the majority of students in college since the mid-1980's, but only six percent of women enter college to pursue engineering (Good, Rattan, & Dweck, 2012; Legewie & DiPrete, 2014; Shapiro & Sax, 2011). This has consistently remained low and flat. For every two women, there are eight men who enter engineering programs (National Science Foundation, 2017). And, the attrition of women from engineering is approximately 34% (National Science Foundation, 2016).

There are currently insufficient numbers of skilled men and women to fill positions in STEM (Bureau of Labor Statistics, 2014). The problem is simply stated that fewer women have entered engineering and approximately one-third leave the major or even leave college. If women remain underrepresented in college in the critical STEM majors, such as engineering, there will be a continued trend of insufficient numbers of professional women to fill these important jobs in the labor force (Goan, Cunningham, & Carroll, 2006; Xu, 2017). In order for the United States to remain competitive in a global economy and fill the demand for skilled workers at the local and national levels, the gender gaps in STEM majors and the retention problem must be remedied (Legewie & DiPrete, 2014). More importantly, in order for women to be more fully represented in all fields and at all levels, remediation of gaps in the educational pipeline, retention, and the advancement of women in the workforce also need attention.

With the problem identified, the questions remain on how to increase and retain the a higher number of women in engineering. One possibility for recruiting and retaining more women in engineering could be through high impact practices in college. High impact practices are programs that correlate with higher degrees of engagement in college, which have a resulting effect on retention and degree completion (Astin, 1999; Brower & Inkelas, 2010, Hixenbaugh, Dewart, & Towell, 2012; Rocconi, 2011). Living-learning communities are one example of a high impact practice in college. Living-learning communities have proven benefits to the entry, transition, and retention of students (Astin, 1999; Inkelas, 2011).

The purpose of this study was to conduct a program evaluation of a women-only engineering living-learning community in order to assess the impact of the program on the recruitment and retention of women in engineering at a public, co-educational research university. This study also sought to identify the experiences of the participants in the women-only engineering community. Living-learning communities can have important implications for the recruitment and retention of women in engineering.

While prior research explored the benefits of living-learning communities, few studies have investigated the impact of a women-only community on the persistence of women in engineering through the lenses of social capital, the impact of social networks as a form of capital, student involvement, and expectancy-value motivation theory. This discussion includes a summary of the findings, suggestions for higher education administrators and educators, future considerations, and questions that emerged from this research.

7.2 Research Design Overview

In order to better understand the impacts of a women-only living-learning community for engineering students, this study examined how gender, ethnicity/race, and high school achievement affected the outcomes of retention in engineering and academic achievement in college. Methods included collection and analyses of data and student interviews. The experiences in the living-learning community, as discussed in the interviews, provided information on the social, emotional, academic, and professional impacts of belonging to the women-only living-learning community. Demographic, academic, and retention data were extracted and analyzed from student records. Triangulations of all data were identified.

Data were collected through both quantitative and qualitative research methods. Quantitative data were downloaded from college admissions records and from the student record database, with permission of the Registrar, the School of Engineering, and the Enrollment Management offices. Qualitative data were collected through semi-structured individual interviews, conducted by me, for approximately one hour with each of the 21 participants.

The participants were selected from a sample of students in each cohort of the Reilly-Douglass Engineering Living-Learning Community from inaugural year of the community (2012) through year four (2015). There were five students interviewed from each cohort and one student who left the program from the first cohort. She left college after changing her major and then at the end of the first year. The sample therefore consisted of 21 women. Questions based on the Academic Pathways Study (APS), conducted by the Center for Advancement of Engineering Education (CAEE) were modified and used to guide the semi-structured interviews[2].

7.2.1 Persistence

Persistence in engineering was measured by retention in an engineering major. Retention was identified both in student records and factors that affected retention emerged in interviews. Important insights regarding the impact of the living-learning community on retention were identified.

Student retention in engineering was assessed at the end of year one and at the end of year two. Findings indicated that women in the Reilly Douglass Engineering Living-Learning Community had the highest retention in engineering both at the end of year one and at the end of year two when compared with men in engineering and women in engineering that did not participate in the women-only living-learning community.

Interviews provided insights into why students persisted in engineering, particularly when things became difficult. Related to the Expectancy-Value-Motivation theory students expected that the community would be a supportive network of women going through the same things at the same time, as a byproduct of pursuing the same major at the same time. Those students who persisted in engineering at the end of year one expected that they would become engineers. The value of earning the degree remained important and students remained committed to endure academic, social, and

---

[2] Used with permission: Sheppard, Atman, Fleming, Miller, Smith, Stevens, Streveler, Clark, Loucks-Jaret, & Lund, 2010, pp. 3C 26-32.

emotional difficulties in order to become an engineer. Student motivation to persist varied. However, what was consistently reported was how the social network itself, the supports that emerged, the bonding between community members, and social capital inherent in the network were instrumental in keeping students engaged and motivated to persist. Student engagement was both within the living-learning community network and between networks within and external to the university.

Factors that contributed to the outcome of retention were the social, professional, emotional, and academic supports that were created through the formation of a social network. The resources that were inherent in the network included friendships, group and individual support with academics, social engagement with individuals and groups, and connections to resources. The social relationships that resulted from living and learning together were important to the students in keeping them motivated. Students reported that when they felt discouraged, women in the community provided encouragement and clearly communicated with each other that, "they were in it together" and would not let each other fail.

For many participants, these strong relationships extended beyond the first and second years of their program. Engagement within and outside the network included relationships with peers and with faculty and staff that were perceived as mentors and supportive. The students that persisted, which was the majority of students, had the expectation that earning the engineering degree was worth the academic and emotional difficulties that they experienced. The short-term difficulties were worth achievement of the long-term gain of becoming an engineer.

7.2.2 Academic Achievement Outcomes

College academic performance was measured via engineering Grade Point Average (GPA) the first two years of college enrollment. Outcomes revealed that Reilly Douglass women were more likely to have a grade point average that was 0.28 point higher than the reference group, adjusting for all other variables. This was statistically significant ($p \leq .016$).

7.3 Race/Ethnicity of R-DELLC Students

Participation in the Reilly-Douglass Engineering Living-Learning Community remained a significant factor when race/ethnicity was considered. There were proportionately and significantly ($p=.00$) more Black/African women in the Community then in either of the comparison groups (men and women not in the community). The majority (57%) of all women in the Reilly-Douglass Engineering Living-Learning Community did not identify as White.

This chapter summarizes the findings and was divided into the following sections: (a) research questions aligned with outcomes; (b) outcomes aligned to theoretical frameworks; (c) limitations, implications, and recommendations for higher education professionals and (d) recommendations for future research.

7.4 Research Questions Aligned to Outcomes

The research questions that guided this study were:

1. Does a women's-only living-learning community affect the recruitment of women into engineering?

2. Does participating in a women's-only living-learning community affect the retention rates of students in the engineering LLC at Rutgers?
3. How do the undergraduate women in the Reilly-Douglass Engineering LL (R-DELLC) compare academically with men and with undergraduate women in engineering at RU-NB who were not in that community?
4. How do participants in the Reilly-Douglass Engineering Living-Learning Community experience the community including its strengths and weaknesses?

Table 19 is a summary of the research questions aligned with methods and data source.

Table 19. Research Questions Aligned with Methods and Data Source

	Interviews	Analysis of Data		
Research Questions	**Students in DELLC (individual interviews)**	**College Record/Transcript**	**High School Transcript**	**Published research**
Does a women's-only living-learning community affect the recruitment of women into engineering?	x			
Does participating in a women's-only living-learning community affect the retention rates of women in engineering?	x	x		X
How do the undergraduate women in Reilly–DELLC compare academically with men and with undergraduate women in engineering at RU-NB not in the Reilly-DELLC?	x	x	x	
How do participants in the Reilly-DELLC experience the LLC, including its strengths and weaknesses?	x			x

7.4.1 LLC Impact and Outcomes on Recruitment

The first research question was whether a women only living-learning community affected the recruitment of women into college engineering majors. Recruitment of women into engineering was measured as a proportional change in enrollment of women in the School of Engineering in a four year time period. The time period was from the inaugural year of the R-DELLC (fall 2012) through fall semester 2015.

The change in women engineering students in the four year time period was a 24% increase. This increase was statistically significant ($p \leq .016$). The numbers of women in engineering at Rutgers University had increased above the national average.

In the third year of the living-learning community, there was a 29% increase in women over the prior year. It was noted that the increase in the total numbers of women in engineering was despite a decrease in the total numbers of all students that year. By the third and fourth year of the living-learning community more women enrolled in engineering than were statistically expected. This finding provides data that more women were recruited into engineering.

There were consistencies in findings (triangulation) between the quantitative and qualitative data regarding recruitment. The quantitative data objectively confirmed a significant increase in the numbers of women in engineering from the inception of the women-only LLC. Qualitative data, collected through individual semi-structured interviews revealed that students had enrolled in Rutgers because of the availability of a women-only LLC. Participants indicated that they expected that they would feel comfortable being surrounded by and living with women going through the same things they expected to go through. The participants acknowledged that they were aware of being outnumbered by men and that they anticipated the support of other women would be helpful to them, especially when things would become difficult. They also indicated that by being part of a small community it would be easier to make friends right from the beginning.

Nationally, only three percent of women enter college intending to major in engineering. The enrollment outcome in the third year of the existence of the R-DELLC was a 29% increase of women. Overall, enrollment of women increased by 24% in the four years from the inception of the women-only LLC. This outcome suggested that the impact of a women-only living learning community in engineering positively affected the recruitment of women in engineering.

7.4.2 Impact of LLC on Retention of Women in Engineering

The second research question considered whether participation in a women-only living-learning community increased the likelihood of retention of women in undergraduate engineering. Retention was measured via the identified major in student records at the end of years one and two. All students in engineering declare their specific engineering major by the end of the first year. Predictors of retention were SAT math scores and high school GPA. For every 100 point increase on SAT math score, the likelihood of a student being retained in engineering in year one was

An analysis of retention in engineering at the end of years one and two revealed significant differences between the three groups of students. The retention for women in Reilly-Douglass Engineering Living-Learning Community was higher than that of men and higher than women who were not in the Reilly-Douglass Engineering Living-

Learning Community. While R-DELLC had a higher retention rate in engineering, it was not statistically significant.

In year two, the women in the Reilly Douglass Engineering Living-Learning Community had the highest retention rate (100%). Men had an 88% retention rate and 89% of women who were not in Reilly-DELLC were retained in engineering in their second year. It was noted that for student in R-DELLC, if they were retained in engineering at the end of year one, then they were retained through their fourth year.

Findings in this study revealed that gender, high school grade point average, and math Scholastic Aptitude Test scores were predictive of the likelihood of retention in engineering. In this study, high school grade point average was consistently the strongest predictor of engineering retention. Scholastic Aptitude Test Math scores was an additional significant factor in student retention.

7.5 Academic Outcomes

The third research question investigated how women in the Reilly-Douglass Engineering Living-Learning Community compared with other engineering women (who did not participate in that community) and how women in R-DELLC compared with men in engineering at Rutgers. Comparisons were defined as college achievement, which was measured via engineering grade point average at the end of year one and year two.

Prior research has shown high school grade point average to be a strong predictor of college achievement (Bridgeman, Pollack, & Burton, 2008). Grades in math and science courses, and college aptitude tests in math were found to be strong predictors of college success in STEM majors (Brown, Halpin, & Halpin, 2015).

Men entered Rutgers School of Engineering with a significantly lower overall high school grade point average than all women. Although not statistically significant, women in the Reilly-Douglass Engineering Living-Learning Community entered college with the highest average grade point average of all engineering students, but the lowest overall SAT scores.

At the end of the first year, the women in Reilly-Douglass Engineering Living-Learning Community had, on average, significantly higher engineering grade point averages than the two comparison groups. At the end of year two, although not statistically significant, it was interesting to note that on average, women in the Reilly-Douglass Engineering Living-Learning Community still had the highest grade point averages as compared with men and with women not in the living-learning community.

While it was significantly predicted that higher Verbal SAT scores more likely predict students' departure from engineering (every 100 point difference in SAT Verbal score increased the odds of a student leaving engineering by 29% their second year (p=.003)), it was important to note that this was not the case for the Reilly-DELLC students. Reilly-DELLC students that were retained at the end of their first year had a 100% retention rate in engineering each year through to their fourth year. This is noteworthy because women in the Reilly-Douglass Engineering Living-Learning Community entered college with the lowest mean combined SAT scores but the highest mean high school GPA. Yet, in both years one and two, the women in R-DELLC had the highest rate of retention and earned the highest engineering GPAs of the three groups. The predictors of retention would suggest that lower SAT scores would result in lower retention. However, given the high retention of women in the R-DELLC, it is plausible that due to the intervening supports provided though the community, retention was improved.

7.5.1 Experiences of LLC Members

The final research question explored how participants in the Reilly-Douglass Engineering Living-Learning Community program experienced the community including its strengths and weaknesses. Semi-structured individual interviews revealed themes of community, friendship, and support. Students consistently credited persistence in engineering to the support of their peers in the living-learning community, being able to see themselves because of the adult mentors and role model who were women faculty and staff, and to their own personal motivation to become an engineer.

Students indicated that they were able to rely on the women in the Reilly-Douglass Engineering Living-Learning Community, especially when things were difficult. Many of the students said that their best friends were other women in the living-learning community and described them as people they would trust with their lives. When asked why they joined the living-learning community, the majority said that it was comforting for them to know that they would be entering a group were the women around them would be going through the same things that they would be experiencing.

Prior to enrolling and during their undergraduate career, the LLC participants anticipated having a built-in peer support network. Many of the students expressed similar values, such as going into engineering because they wanted to make the world a better place. Several spoke about how they would use what they learned in engineering to solve global problems, such as water purification systems in third world counties, or cost-effective cooling systems in poor areas so that people don’t die from extreme heat conditions in geographical areas where that problem exists.

7.5.2 Weaknesses of the LLC

Weaknesses of the Reilly-Douglass Engineering Living-Learning Community were feelings of disappointment about not getting to know many of the women in the Douglass-Engineering community who were in different class years and not having as much interactions with students who were not living on their floor the first year. While the living-learning community was in one wing of a co-educational residence hall so that men and women were in another wing of the same floor, the students reported limited interactions with people who were not in their immediate proximity. Many wished that they could have lived with students in the Reilly-Douglass Engineering Living-Learning Community for all four years, but after the second year the format was not designed to keep all of the students on one floor of the same residence hall.

7.6 Theory and Outcomes

Men predominate engineering programs, with roughly women 20% women in the undergraduate engineering programs. The value of high impact practices in higher education, such as living-learning communities, may have a positive impact on the recruitment, achievement and retention of women in engineering. The results of this study were aligned with the following theories:

1. Social capital with the impact of social networks;
2. Expectancy-value motivation; and,
3. Student involvement theories.

These theories complemented each other because fundamental to each was the role of social networks, access to resources, the influence of networks on motivation and persistence, the social cohesion of the group, group identity, support of members within the group, encouragement between the group members, and the importance of involvement and active participation in groups and networks.

The Eccles [Parsons], Adler, Futterman, Goff, Kaczala, Meece, & Midgley (1983) model of Expectancy-Value theory is a motivational theory that considered self-evaluation as well as the influences of others in a person's network. Expectancy is the self-evaluation of ability to succeed in accomplishing a task (e.g. *Can I be an engineer?*). Value is a cost-to-benefit analysis which considers cost in broad terms including time, money, not being able to do other things while pursuing the task, etc. (e.g. *Do I want to be an engineer?*). The outcome of expectancy and value is then the motivation to persist. (Matusovich, Streveler, & Miller, 2010b, Eccles et al., 1983). This expectancy-to-value decision is influenced by the behaviors and attitudes of important people in an individuals' life (Eccles, 2011). The motivation to persist is a continuous self-evaluation that is not done in isolation. People's decisions are regularly influenced by their network(s).

In my research, students consistently spoke of their own motivation to be an engineer and the influence of their peers in helping to sustain their motivation. Many students spoke of wanting to become an engineer in order to *make the world a better place.* They wanted to solve problems that could impact people on an individual level and on a societal level. Students were asked if they had ever thought of leaving the engineering program and if so, what made them stick with it when things got difficult.

For those who had thought of leaving, several said that the encouragement of their peers in the living-learning community helped to keep them going, especially when things became difficult. They said that their peers in the living-learning community understood what they were going through and were a supportive source of help. For those who indicated that they had not thought of quitting engineering, they cited reasons such as, *I know that the ladies around me (LLC) would not let me quit and I didn't want to leave them or let them down* (peer influence); or *my family is so supportive and when I think of what may parents sacrificed for me to be an engineer, I can't quit* (family influence).

In addition to knowing that there was a network of supportive women, the students indicated that they had an internal drive to succeed. When things became difficult, a common theme from the interviews was that the students focused on their goal of becoming an engineer. They accepted that things will be difficult at times, but that if they stick with it, they will succeed, even if they don't get the grade that they wanted.

Social capital theory, which considers the social networks, social cohesion, interpersonal trusts, and reciprocal relationships between people and how that directly relates to benefits and outcomes, was another framework for my research (Carpiano & Fitterer, 2014; Coleman, 1988; Ertel, Glymour, & Berkman, 2009; Moore, Bockenholt, Daniel, Frohlich, Kestens, & Richard, 2011; Putnam, 2003). Social cohesion is an important factor in the creation of social capital; and once capital is created, the group members gain access to it (Almeida, Kawachi, Molnar, & Subramanian, 2009; Carpiano, 2008). People who reported having close friends and/or belonging to community or organized groups benefit from the support and social influences provided through networks (Bircher & Kuruvilla, 2014). Social capital also creates bridges to other resources, information, and people, which expands and enables entrée to even more resources (Fung & Hung, 2014; Granovetter, 1983). The resources (actual and potential) within networks can be in form of material, information, psychological support, and/or social relationships (Carpiano & Fitterer, 2014; Sadovnik, 2007).

Social capital theory is the fundamental framework of a living-learning community. The formation of the Reilly-Douglass Engineering Living-Learning Community was the intentionally created environment that facilitated the creation of social networks, the connections of students to each other, and direct access to key faculty and staff. Capital was built from and inherent to the community. The Reilly-Douglass Engineering Living-Learning Community offered enhanced academic and co-curricular learning opportunities, and links to other resources.

The students in Reilly-Douglass Engineering Living-Learning Community lived together in a relatively small and cohesive group in a residence hall. They shared the same major, took engineering-related courses together in the first year (which offered an additional layer of emotion and academic support), and as a group participated in the course-in-residence, which was open only the members of the living-learning community. This course-in-residence helped the students explore the disciplines within engineering in their first year so that they could identify a specific engineering major before the start of the second year. Many of students in the Reilly-Douglass Engineering Living-Learning Community named their role model as the woman faculty member who taught the course-in-residence (Engineering Explorations). Some students also named that professor as a mentor.

Research by Brower & Inkelas (2010) determined that students who participated in Living-learning communities had access to resources with fellow students, faculty, and administrators. Inkelas reported that students studied more frequently with peers, engaged in more academic and socio-cultural conversations with their peers, and interacted with faculty members on course-related topics. The students in living-learning programs also reported feeling that their residence hall had a supportive and tolerant environment (Brower & Inkelas, 2010).

My research on the Reilly-Douglass Engineering Living-Learning Community had similar results to Brower and Inkelas (2010). The students in Reilly-Douglass Engineering Living-Learning Community reported that they often interacted with the other students in the living-learning community, both academically and socially. They relied on their peers in the living-learning community to help solve complex homework problems, studied together, ate together, and join co-curricular groups such as the student chapter of the Society for Women Engineers. Reilly-Douglass Engineering Living-Learning Community student also had direct access to engineering faculty and staff.

An understanding of social networks as part of social capital was a third focus for my study as it considered the shared ties and interconnectivity of people and resources surrounding an individual. Social networks focus on the structure of a network, including the resources that are available in or which flow through the network (Berkman, Glass, Brissette, & Seeman, 2000; Putnam, 2003). Considering living-learning communities as functioning social networks helps to frame research primarily because it broadly considers the networks and social cohesion between people and how this directly relates to benefits and outcomes.

Within a social network, core relationships are critical as they represent stronger ties. Core relationships provide support (including emotional support), influence behaviors, and provide advice to its members (Moore et al., 2011).Support is often thought of as a function of the network (Berkman, Glass, Brissette, & Seeman, 2000; Ertel, Glymour, & Berkman, 2009). Research has shown that communities of support are important for student engagement and retention in college (Astin, 1984). Communities of support, such as those created though an living-learning community may be a way to help women students remain in engineering since academic achievement, alone, can not explain why women leave engineering at higher rate than men (Galdi, Cadinu, & Tomasetto, 2014).

There was a strong correlation between student co-curricular engagement and positive experiences in college, which can lead to educational retention (Astin, 1984; Sax & Shapiro, 2011; Siefert, Gillig, Hanson, Pascarella, & Blaich, 2014). Involvement also helps students with the transition into college including academic, social, and emotional adjustments. Higher levels of engagement relate to student retention and college completion rates (Astin, 1999; Brower & Inkelas, 2010; Hixenbaugh, Dewart, & Towell, 2012; Rocconi, 2011).Student involvement in college can happen in different ways such as, through sports, Greek life, leadership roles, student clubs, associations, student government, and/or living-learning communities.

Student involvement theory layered with the other theories that guided my study. The results of my research showed that women in the Reilly-Douglass Engineering Living-Learning Community were involved with each other and in the larger college community. Of those interviewed most were a member of the student chapter of the

Society of Women Engineers. Other clubs and organizations that the R-DELLC students participated in were an engineering sorority, other types of engineering clubs, sports, and other types of non-engineering college clubs. Many of the students held leadership positions in the clubs and organizations in which they participated.

Overall, the quantitative and qualitative data in this program evaluation suggested that since the inception of the Reilly-Douglass Engineering Living-Learning Community (for undergraduate women engineering students), the numbers of women engineering students increased beyond that which would have been predicated. Students who participated in Reilly-Douglass Engineering Living-Learning Community had the highest retention rate when compared with men and with women not in the living-learning community. In addition to the qualitative data analysis, the qualitative data, obtained through individual interviews, provided corroborating information that the students persisted in the program because of the friendships, sense of community, and both academic and social support of women students in the Reilly-Douglass Engineering Living-Learning Community.

The components of the social network were instrumental factors in helping them stay in engineering when things became difficult. The social network and social capital available through the community provided important emotional and tangible resources that helped them persist. Tangible resources access to staff and faculty, additional tutoring, funded research opportunities in the first year, and physical proximity of community members. The students interviewed indicated that the network of support from their peers and from staff/faculty contributed to their persistence in engineering.

The students in the Reilly-Douglass Engineering Living-Learning Community cited women faculty who were perceived as role models that were important to them.

It was noted that all 18 women who remained in the Reilly-Douglass Engineering Living-Learning Community from the end of their first year were on the verge of graduating four years later with a degree in an engineering major. They completed their degree in four years. One important factor that was noted through the interviews was that students were able to persist because they learned to develop a resiliency. Once they understood and accepted that success can be defined differently than they expected – that they didn't have to get all "A" grades as they may have done in high school or as they expected of themselves, then they understood the connection between their performance and being able to remain in engineering. The women then accepted that they could fail a test, and learn from their failures -- but still become an engineer. Gaining that understanding and the resiliency resulted were turning points for the participants in the sample. Until that point they had thoughts and feelings of not belong in the engineering program, self-questioned, "what was wrong with them," and believed that everyone else seemed to understand but they didn't.

In order to recruit and retain more women in engineering it was important to understand the experiences of the students in this living-learning community for engineering women and to then use the proven high impact practices in higher education. A single gender living-learning community was shown to be highly effective in bringing more women into the educational pipeline for engineering and demonstrated a high rate of retention. By understanding that important social capital was created and available through the living-learning community, which helps to recruit and retain women in engineering, this model of a high impact practice can be viewed as a an important way to increase the pipeline for this and other majors in which women are underrepresented in college majors and the workforce. The model was based on the intentionality of creating a supportive network comprised of peers, graduate students, staff, faculty, and specialized learning opportunities. The components of this model of education included:

- A single-gender living community of no more than 32 students with contiguous room assignments in a residence hall;
- All students in the community have the same major. This facilitates the building of the community because the students become the first layer of support to each other. They have common experiences, the same classes, and common understandings which benefits the network ;
- Students live together for a minimum of two years: the first and second years of college. This time frame provides a sufficient length of time for the members of the network to generate capital within the network and link or bridge to resources outside the network in order to benefit themselves and others in the network;
- Provide intentional layers of support in the network (community) with the following components:
    - peer mentoring from an upper class student in the same community/same major;
    - an assigned graduate mentor as an "in-residence" resource;
    - free tutoring specific to difficult courses in the major;

  - free resources/services (e.g.: meetings, tutoring, in-residence courses) held at night in the residence hall specifically for the students in the target community;
  - faculty and staff that are women and are available to act as role models and mentors to students of all years in the community;
  - connections to funded (or unfunded) research opportunities;
  - encouragement to present research at relevant national conferences;

- Intentional outreach from women faculty and staff to the students. Create an environment where the students feel valued in and out of the classroom. The personal connection is important to women and taken seriously in an academic setting is critical to feeling valued.
- Require diversity and inclusion training for faculty. This may help educators to be sensitive to gendered differences in learning and the unintentional or intentional treatment of women in the classroom. Prior research has shown that “bias blind spots” exist whereby people are not aware of how they treat others and believe that they do not act in biased ways (Pronin et al., 2002). When male faculty, “go easier” on women students, it is perceived by the women as demeaning, unwelcomed, and unfair. Women interviewed in this study feel as if the male professors were talking down to them and it made them feel babied and marginalized.

7.7 Limitations

All research studies particularly those involving human subject research have limitations. There were several factors that impacted the outcomes of this study. The major limitation was my dual role as a university administrator and a researcher for a project in my unit (Belichesky, 2013; Semel, 1994). As the Associate Dean of the college, I was initially involved with the recruitment of women to the Reilly-Douglass Engineering Living-Learning Community. I have remained involved in the planning and administration of the community since its inception. My position within this study meant that I had to be diligent in protecting the subjects, aware of my bias, and how my dual role may have affected the study (Semel, 1994).

There are other limiting factors in this research. The sample was limited to students in engineering at Rutgers University–New Brunswick. Therefore, any conclusions of my research may not be generalized to the larger population. There was also selection bias for students who choose 1) to enroll in any living-learning community; and 2) for those who then choose to enroll in a women-only community (Messina, 2011). The students who participate in the Reilly-Douglass Engineering Living-Learning Community entered the community through self-selection. Therefore, the sample may not be a representative sample of women in engineering because those students who choose a women-only community may differ from those who would not choose to apply to a single-gender community.

Lack of graduation data was a limiting factor in this research. Graduation data was not available because of the date the data was pulled for the research. The data was downloaded and delivered the first week of May 2016. This was a few weeks prior to graduation. The first cohort of students that entered in fall 2012 was poised to graduate in May 2016. When interviewed in mid-May, just days before University Commencement, the students who were finishing their year anticipated that they were graduating with a degree in engineering. I inferred that they did graduate as planned. Future research would include comparative graduation data and would be downloaded after the semester was completed and all grades entered.

Another limitation was that each year there was a cap on the number of students that can be accommodated in the community. The annual cap of the maximum number of first-year women students permitted to join the community was based on the number of rooms designated by the School of Engineering to be women-only room in the residence hall. Housing then reserves the block of rooms in the same floor and section of the first-year engineering residence hall so that these rooms can be grouped together and reserved for the community. Each year from year one (2012) through 2015, more rooms were assigned so that each year the community could be expanded in the number of students that could self-select to enroll. The first year ten (10) rooms were reserved for twenty (20) incoming engineering women. By the fourth year, 17 rooms were grouped together and reserved for women in the Reilly-Douglass Engineering Living-Learning Community. As there was a waitlist for students to enroll in the Reilly-Douglass Engineering Living-Learning Community, it was not known how dynamics or outcomes would have changed with additional community members.

Further limiting the sample was that students were enrolled in the Reilly-Douglass Engineering Living-Learning Community based on a first-come/first served model. However, there were students, each year that wanted to be in the community and were rejected because they did not get their application submitted on time to be on the list. It was a first-come, first-served assignment into the Reilly – Douglass Engineering Living-Learning Community. Therefore, the sample was a self-selected group as well as limited by the number of students who can be accommodated in the allocated space, which was a maximum of 34 women by year 2015. In addition to being a self-selected sample, the outcomes may have been different had there been criteria set to enroll in the community, rather than first-come/first served. Another selection option for the community that may have changed the outcome of this study would have been if students were randomly selected for the Community.

There were sufficient numbers of men and women in engineering each year over the four-year period of this study. However, the sample size of women in the Reilly – DELLC community was small. This was because the program had not reached full capacity of enrollees by 2015, meaning that there were not 32 women in each cohort. As the program ramped up, more students were added, up to capacity. So, the first class was almost one-half the size of the class that entered four years later in the fall semester of 2015. The community was limited in the number of students that could participate each year.

Regarding the data, quantitative data used in this study are limited by the quality of the institutional data and are representative only of the specific population of engineering students. As with most qualitative studies, the small sample size allowed the experience of the participants to be more fully understood, but limited the ability to generalize results to other populations.

Further limiting the study was that all of the interviews were only from a sample of students who participated for at least one year in the Reilly - Douglass Engineering Living-Learning Community. Interviews were not conducted with men or with women who were not in the Reilly - Douglass Engineering Living-Learning Community. There were also no alumnae of the Reilly-Douglass Engineering Living-Learning Community at the time that the data were collected. This limited the information about retention in engineering post-graduation. The collection of longitudinal data and the inclusion of alumnae are suggested as further research in order to determine if the students who enrolled in and graduated as members of the Reilly-Douglass Engineering Living-Learning Community entered the engineering field and for how many years post-graduation were they were retained.

Another limitation was that qualitative data were only collected one time, through a single interview. While quantitative data were collected each year and over four years, the qualitative data were a one-time snapshot in time. It would have been interesting to interview the students in each cohort each year of their undergraduate education. This type of longitudinal data may have provided valuable qualitative data at different points along their educational pathway as compared with a one-time snapshot.

Waldron and Yungbluth (2007) found that in the study of living-learning communities sample size tends to be small. This case study was limited to qualitative data from the sample of women in the living-learning community, which was a small sample and only over four years. That limited the data to one full cohort of students that experienced the full four years. Only 18 students in the Reilly-Douglass Engineering Living-Learning Community had experienced the full four years of the program. Students in the other cohorts were progressing towards degree completion at different stages in their undergraduate academic careers. Although participants offered insights into their experiences, they do not necessarily represent the experiences of other women undergraduates in the School of Engineering, or the even the larger group of engineering students in general. Although similarities and common themes were apparent in the participants' stories, it was likely that a larger sample size would have uncovered additional reasons students persist in engineering and their experiences.

Another limitation was that the interviews were all self-report data and the majority of the sample interviewed were those who persisted for at least one year. It was possible that people do not report accurate information. However, given that the Eccles model was based on a person's beliefs about him/herself, self-reporting was still an appropriate and acceptable perspective for data collection (Matusovich, 2010a).

While I interviewed five students from each year (first year through senior), I was only able to interview one student who left the program. There was only one student interviewed who had left the Reilly-Douglass Engineering Living-Learning Community. While outreach was done to recruit other women who had either changed major or left the University, no other students responded to the invitation to participate in the study. A limitation was the lack of representation of women who did not persist. This loss of valuable information about those who did not persist, their self-perceptions, beliefs in their competency, and their vision for their future careers was virtually absent from this study. I had reached out to all of the students who had started in the Reilly-Douglass Engineering Living-Learning Community and had either left the university or changed majors. I only received a reply from one student. She was the student who had completely left the university and changed her career path to a field not related to engineering. Her passion was for Cosmetology and she pursued that career. The sample size of one (1) for obtaining information about why students left the Reilly-Douglass Engineering Living-Learning Community or why they changed majors was another limiting factor in understanding why students leave engineering. The only conclusion from the outcome of students who stayed at Rutgers but left engineering was that they changed majors. There was no further information about *why* they changed majors because of the inability to interview them.

A final concern was that there was no qualitative data collected for men or for women not in the living-learning community. No interviews were conducted for women and/or men who were in engineering but did not participate in that community. The interviews were limited to a sample of women in the Reilly-Douglass Engineering Living-Learning Community.

While all research, including this study has limitations, this research contributed to an increased understanding of the role of living-learning communities in the recruitment, persistence, and retention of women in engineering. The outcomes of a women-only living-learning community were documented. High numbers of women from the Reilly-Douglass Engineering Living-Learning Community were retain each of the four years and subsequently graduated with an engineering degree as compared with the national average. This success suggested that the components of this living-learning community could serve as a model for the recruitment and retention of undergraduate women in engineering. Information and successes which contributed to the understanding of how to encourage and how to graduate more undergraduate women in engineering could help to increase the number of women engineers in the workforce, globally.

7.8 Recommendations to Higher Education Administrators

This section offers recommendations for higher education professionals with regards to positively impacting the recruitment and retention of women in engineering. A primary recommendation is for colleges/universities to consider living-learning communities, as a way to address the social, emotional, and academic needs of entering college students. Living-learning communities have proven success for students especially in the first year of college.

7.8.1 Living-Learning Communities Engender Involvement

A living-learning community for women in engineering, or any discipline in which women are underrepresented, can engage students. Living-learning communities are recognized as a high-impact practice in higher education (Brower & Inkelas, 2010). A first-year living-learning community can create an environment where students feel welcomed and included from the time that they are committed to enrolling in the college/university. This type of student engagement, that occurs from the start of a student's college career and begins to build even before they officially begin their academics, offers a community of like-minded students focused on a common theme or major can provide the needed academic, emotional, and social support. The explicit and implicit support of a community that occurs when student live, socialize, learn, and share common experiences then creates the social capital and a resulting social networks (generated through and between the members of the living-learning community) which can create the connections and resources that students use to persist. The benefits inherent in a social network are conducive to creating an environment of support, which is conducive to persistence.

7.8.2 Supportive Environments

Academia traditionally values achievement (grades) as a primary goal, sometimes with little development of other factors that lead to success. Higher education has the foundational structure of human, social, material, and knowledge capital that could and should address the social and emotional needs of students in an holistic way. Students of all ages and of varying majors may choose to live and learn in face-to-face classes on a college campus. This creates an environment where college personnel can intentionally create communities of support with and among peers and staff. Living-learning communities are one way to facilitate the building of networks, access to resources, and the needed social, emotional and academic support for students. This is particularly important for students who are underrepresented in any way.

7.8.3 Inclusive Spaces

Living-learning communities have the potential to create inclusive spaces that lead to engagement, persistence, and retention. This information may be useful to colleges and universities that are considering a living-learning community as a potential tool for the recruitment and retention of women or any underrepresented/minority group in a major in which the underrepresentation exists. Living-learning communities, or learning communities (without the residential component) can be considered for any population of students who have the academic ability to succeed but may face other challenges that become barriers to entry, persistence, and/or success.

7.9 Strategies for Helping Women Become Engineers

Many factors interrelated for the recruitment and retention of women in engineering. In particular participation in the Reilly-Douglass Engineering Living-Learning Community facilitated students feeling connected to each other, and to staff and faculties, which they perceived as supportive resources. The friendships, which were an outgrowth of the community, fulfilled an incoming expectation that many of the students had in which they would identify with other women engineering students and that those women would understand the issues they faced as women and as engineering students in a male dominated field.

7.9.1 Visualizing the Future as an Engineer

One outcome of my research was that the students who persisted were able to see themselves as engineers in the future. They were able to communicate why they stuck with it when things became difficult. And, for the majority of the students, their persistence was attributed to an inner drive to become and engineer in order to make the world a better place. The value of the degree factored into the motivation to persist, despite difficulties and failures.

7.9.2 What Engineers Do

The understanding of what it means to be an engineer for the women in this program was an important finding for educators. Students who developed an understanding of what an engineer does and what it means for them to become an engineer, in order to impact the world in a positive way, helped women to maintain an inner drive to persist. Educators have a responsibility to help students make the connections between what they learn in a classroom and what they will do as engineers in the workforce, in the future. Students often enter college without knowing what an engineer can do or the different disciplines within engineering. Direct instruction on what it means to be an engineer may have an important influence on the retention of women in engineering.

This study also reinforced that educators should expose students to types of engineering career options including the different disciplines within engineering, the types of jobs engineers can do, and where engineers can work. The women in this study indicated that the direct, hands-on learning that they had in the Engineering Explorations course fulfilled that need for them. Not only did they learn about the different fields in engineering, but, because women engineers in each of those fields led the classes, the women in the class benefitted by being able to identify with women role models and were able to then "see themselves" as engineers. The classroom projects also enabled the students to work together and learn together. Because they also lived together, the social and academic benefits were reinforced.

7.9.3 Cohesiveness and Identity

Another factor affecting their retention was the social network that the women developed through the living learning community, in which they created a cohesive community with a distinct identity. The sharing of information, resources, and support provided an academic and social environment where the students encouraged each other to persist and succeed. Many stated that they would not let another member of the Community fail or quit. The peer encouragement and support became an important motivation to persist and one that educators can foster. The intentional development of a community can result in positive outcomes for women who entered the program hoping for an instant support system and a way to make friends, quickly.

7.10 Advice to Administrators

One issue to be addressed in the future was the disconnect that engineering students in the Reilly-Douglass Engineering Living-Learning Community felt from other students who were physically located on the Douglass campus approximately five miles away and anywhere from a fifteen minute car/bus ride to over an hour depending on traffic. The geographical distance and the schedule of the University buses made it difficult to get from one campus to the other. And, this created a barrier for the students and resulted in students feeling disconnected from Douglass as a College and the larger Douglass community.

The recommendation would be for more student programs to be developed and delivered on the campus where the "remote" living-learning communities are located to not only serve the specific living-learning community, but to also bring students from other campuses and majors together in spaces that are convenient for students on campuses other than the Douglass Campus. By bringing resources, staff, and other Douglass women of all majors together on different Rutgers - New Brunswick campuses, a student's identity of belonging to a smaller living-learning community could be augmented by their identity of being a member of the larger Douglass Residential College Community. That could strengthen their support network and diversify their connections to others. Students who were interviewed consistently spoke about wanting more of a connection to other Douglass students and to the larger Douglass community.

7.11 Recommendations for Future Research

The findings from this study reinforced the need for additional research of the role of living-learning communities for the recruitment of women into engineering; in particular, a focus on the role of a single-gender living-learning community. A deeper exploration of the role of living-learning communities to encourage women into the major when they are high school students could help to increase the numbers of women pursuing engineering.

7.11.1 Need for Additional Data

7.11.1.1 Graduation Data

Graduation data would be critical to collect and analyze in future research. The lack of graduation information available for any of the students in this study was noted as a limitation. In addition to graduation rates, the number of years to graduation would also be important to collect for the three comparison groups. It would be a valuable addition to include cohorts two to four years prior to the target groups so that graduation data can be compared to data prior to the intervention (new living-learning community).

7.11.1.2 Quantitative and Qualitative data

Another recommendation for additional research would be to include more qualitative data, through interviews and focus groups for single-gender engineering living-learning communities, thereby increasing information about the experiences of women in engineering. In order to further examine the model of a single gender living-learning communities for women in engineering, it was important to more deeply explore the experiences of women in each year of the living-learning community and post-graduation.

Further research would include interviews with women who were not in the living-learning community. That would help to assess their experiences and provide the opportunity to compare the experiences of women in the community with those who did not participate in the community. Similarly, interviewing men would provide information on their experiences in-and out- of the classroom which could provide interesting insights into how men perceive themselves as students in engineering and how they relate to women engineering students. Qualitative data from co-educational groups and men-only living-learning communities would strengthen the research and provide the ability to explore if the strong feelings of community experienced by the women in this program are experienced by women in co-educational communities or by men in men-only living-learning communities.

7.11.1.3 Gendered Learning Differences

Belenky, McVicker Clinchy, Goldberger, and Tarule (2002) provided insights into gendered learning in the classroom. Women often feel unheard, even after they find their voice and believe they have something to contribute. A similar finding emerged from this research study. Women who were interviewed were aware of first feeling overwhelmed and self-doubt as to whether that what they had to say in the classroom might (or might not be welcomed). This phenomenon was also found in the current research where women reported that they often felt tired and overwhelmed. Men can be wonderful and allies should work together for the benefits of the students. Students had direct experiences where they found their voice to speak up but were then dismissed by others or were told that their answers could not be right (when they were). At times a women gave the same answer as a man, but the women's answer was dismissed or told that the answer was wrong, despite the answer actually being correct..

7.11.2 Intended and Declared Majors

It may be interesting in further research to look at the intended majors of students and the actual declared major of students two years later. Analyses around what helped them decide on the majors, comparisons of grade point averages of students in each major, statistics of the proportion of men and women within each major, and any other factors that may provide information on how men and women select engineering majors could be of value.

7.11.2.1 Longitudinal Data

This study suggested that longitudinal research of living-learning community participants could provide important information from a larger sample of students, over a longer number of years and post-graduation. One cohort of students in this study was followed over four years and through to May of the year they were to graduate. However, the data were collected at the end of their fourth year, just prior to grades and graduation information being posted. This provided a one-time reflection over their four-year experiences.

Further research could collect qualitative data at different points in their undergraduate careers, such as, at the start of their first year, at the end of each academic year, and in particular an exit interview in their fourth year. By exploring the experiences of each cohorts, this would enable an collection of and evaluation of quantitative and qualitative data over a longer period of time for each student that would yield important information to better understand the role of living-learning communities in outcomes for women in engineering. Additionally, at the point that there are four full cohorts and a growing number of alumnae, the data pool will be expanded allowing for a larger sample.

7.11.2.2 Enrollment

The selection criteria to enroll in the Reilly-Douglass Engineering Living-Learning Community may have been a confounding and/or limiting factor, but it was also a consideration for future research. If the enrollment were changed to specific criteria for participation in the community or done by random selection of all the women who applied to be in the single-gender living-learning community rather than by first-come/first served, then different outcomes might be noted.

7.11.2.3 Resiliency

Further research could more deeply explore the literature and the research of resiliency and self-efficacy related to women's retention in engineering. The participants in this study indicated that they had low self-efficacy and questioned their abilities as well as whether or not they "belonged" in engineering *until* they accepted that it was alright to fail, sometimes. Students who were used to being high achievers and getting high grades felt like failures if they earned a letter grade of "C" or lower. Once the students understood that they could get some low grades and still become an engineer, they gained the *resiliency* to persist.

The students in this study deemphasized the importance of grades and focused on understanding the material, gaining knowledge, and being able to conceptualize how they could apply the information in a practical way. They also learned that other students had low grades, too, and they learned the concept of a grading curve, where a low grade might be the highest in the class. Grading curves were a new concept. Some students who thought they had failed learned that their low grade was actually among the highest in the class and this boosted their understanding of their own abilities and reinforced that they 'fit' in engineering.

Additional research could have a stronger literature review on the role of resiliency and retention of women in engineering or other STEM majors. Also, it would be of value to learn whether or not resiliency could be taught to women earlier in their academic career or at all, or if resiliency is something that is experiential. A deeper understanding of personality types and resiliency could also be of value in attempting to diagnose how to recruit and retain more women in engineering and other STEM fields where women continue to be underrepresented. Also, further research could more deeply consider the effects and interaction of both race and gender on the recruitment and retention of women in engineering. Women of color are more underrepresented than white and Asian women in engineering both as students, faculty, and in the workforce.

Future research could consider the opportunity to participate in the Academic Pathways Study conducted by the Center for Advancement of Engineering Education. Permission was granted for me to utilize some of the questions for the semi-structured interview in my study of the Reilly-Douglass Engineering Living-Learning Community and its participants at Rutgers University. However, future research could compare the outcomes found in this study with outcomes from the Academic Pathways Study or related research based on the larger database.

7.11.2.4 Comparative Data

Additional research could enhance an understanding of women's retention in engineering by comparing living-learning communities at other universities, particularly other women-only living-learning communities for women in engineering. It would also be interesting to identify and compare other living-learning communities for women who are underrepresented in other disciplines. Similarly, comparing research results for underrepresented populations (men and women) in any major and the effects of living-learning communities could provide information on the impact of living learning communities, in general, for students who are a minority in any field.

7.11.3 Gendered Differences in Learning

Additional research of how to recruit, engage, and retain women in engineering could explore and include a literature review of the gender differences for learning. That could reveal insights regarding how women best acquire information in the classroom. Further investigation of gendered learning differences could reveal classroom dynamics that may be biased against women and result in disadvantages to women in the classroom.

Women in this study revealed information about how they were treated in the classroom, how they felt in engineering classes, how they were treated by male instructors. This treatment may be attributed to intentional and/or bias blind spot (Pronin et al, 2002). Bias blind spot bias was a term first created by Pronin, Lin & Ross (2002.) Similar to visual blind spots, where information exists in the visual field that the brain does not process, bias blind spot is the space in which a person is not able to be aware of their own biases in the treatment or perception of others.

One of the recurring themes was the need for women to feel valued and respected in the classroom, the need to not have work 'babied down to them,' and the importance of learning that they did 'fit' in engineering even if they earned some poor grades. One component for the success of women in the classroom is for women to develop their own the ability to become academically resilient and accept a certain amount of failure. This was a common theme for the women in this study who did persist in engineering. This research raised the question of resiliency as a factor in the retention of undergraduate women in engineering. Resilience has emerged in the literature on minorities and students of low income, but should also be considered for women.

Finally, further research could consider including the experiences of all students in engineering, including men, and in particular those women who leave the major and/or leave college. As discussed in the limitations, the current qualitative research included only students who persisted in engineering, with the exception of one student who left college completely. It was important to understand why students leave the engineering major and/or resign from college completely. Further research could include an analysis of a student's involvement in college, their motivation for their initial selection of a major and their motivation to remain in that major, and an analysis of their social networks.

7.12 Conclusion

This mixed-method case study sought to gain a better understanding of the experiences of women in a single-gender engineering living-learning community at a large public university between the time frame, fall semester 2012 to spring semester 2016. The components of the living-learning community were identified and the experiences of students in each of the four years (First Years through Seniors) were obtained. A women-only living-learning community was evaluated as a case study to assess its effectiveness as an intervention for the recruitment and retention of women in engineering. The achievement of women in the community was evaluated against men and women engineering students who were not in the community. Given the outcomes identified in this research, a women-only living–learning community could serve as model for women to succeed in spaces where men predominate.

This study highlighted the struggles, doubts, and achievement of women in undergraduate engineering. The layering of residential, academic, and co-curricular components of the women-only living-learning community provided an environment where networks were created, access to resources was facilitated, friendship were forged, research was encouraged, faculty and staff were engaged with the community of women, and students were involved and engaged in academics and co-curricular activities both within engineering and with groups unrelated to engineering. Students participated in non-engineering clubs or organizations that included: student government, comedy groups, greek life, physical fitness, and acting. Results showed positive outcomes in the recruitment, retention, and achievement of women who participated in the R-DELLC.

This original study adds to current research by documenting the quantitative and qualitative outcomes of a living-learning community for women in engineering. The recruitment and retention of women in engineering did significantly increase over the four-year time period, from the inception for the women-only LLC. Through a literature review, no studies were found that evaluated a living-learning community for undergraduate women using the frameworks of Expectancy-Value-Motivation theory, Social Capital/Social Network theory, and Astin's theory of Student Involvement.

References

Al Rubaie, T. (2002). The rehabilitation of the case-study method. *European Journal of Psychotherapy, Counselling & Health, 5*(1), 31-47. doi:10.1080/13642530210159198.

Allan, E. J., & Madden, M. (2006). Chilly classrooms for female undergraduate students: A question of method? *Journal of Higher Education, 77*(4), 684-711.

Ambady, N., Shih, M., Kim, A., & Pittinsky, T. L. (2001). Stereotype susceptibility in children: Effects of identity activation on quantitative performance. *Psychological Science (Wiley-Blackwell), 12*(5), 385.

ASHE Higher Education Report. (2011). *Women's status in higher education* (15516970). Retrieved, https://login.proxy.libraries.rutgers.edu/login?url=http://search.ebscohost.com.proxy.libraries.rutgers.edu/login.aspx?direct=true&db=aph&AN=76550653&site=ehost-live

Astin, A. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development, 40*(5), 518-529.

Astin, A. (1997). *What matters in college: Four critical years revisited*. San Francisco: Jossey-Bass.

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of College Student Personnel, 25*(4), 297-308.

Astin, H. S. (1984). The meaning of work in women's lives: A socio-psychological model of career choice and work behavior. *Counseling Psychologist, 12*(4), 117.

Bailey, S. M. (2017). "Coeds" come to the Ivy League: "Keep the damned women out": The struggle for coeducation. *Women's Review Of Books*, *34*(6), 6-8.

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education: An International Journal, 15*(4), 427-448.

Beekman, J. A., & Ober, D. (2015). Gender gap trends on mathematics exams position girls and young women for STEM careers. *School Science and Mathematics, 115*(1), 35-50.

Belenky, M.F. McVicker , B., Clinchy, G., Goldberger, N., and Tarule, J. (2002). *Women's ways of knowing*: *The development of self, voice, and mind.* New York: Basic Books.

Belichesky, J. (2013). *Living learning communities: An intervention in keeping women strong in science, technology, engineering, and mathematics.* (Doctorate of Education), Loyola Marymount University. (3595015).

Best, K., Sanwald, U., Ihsen, S., & Ittel, A. (2013). Gender and STEM in Germany: Policies enhancing women's participation in academia. *International Journal of Gender, Science and Technology, 5*(3), 292-304.

Bigelow, K. E. (2012). Student perspectives in an all-female first-year engineering innovation course. *International Journal of Engineering Education, 28*(2), 286-292.

Bix, A. S. (2004). From 'engineeresses' to 'girl engineers' to 'good engineers': a history of women's U.S. engineering education. *NWSA Journal* (1), 27.

Bologna, C. (Producer). (24 June 2014). Inspire her mind. [video] Retrieved from http://www.huffingtonpost.com/2014/06/24/verizon-ad-tells-parents-to-encourage-girls_n_5526236.html?ncid=fcbklnkushpmg00000063. Retrieved from https://www.youtube.com/watch?v=XP3cyRRAfX0.

Borman, K. M., Tyson, W., & Halperin, R. H. (Eds.). (2010). *Becoming an engineer in public universities: Pathways for women and minorities*. New York, NY: Palgrave Macmillan.

Bottia, M. C., Stearns, E., Mickelson, R. A., Moller, S., & Parker, A. D. (2015). The relationships among high school STEM learning experiences and students' intent to declare and declaration of a STEM major in college. *Teachers College Record, 117*(3), 1-46.

Brawner, C. E., Camacho, M. M., Lord, S. M., Long, R. A., & Ohland, M. W. (2012). Women in industrial engineering: Stereotypes, persistence, and perspectives. *Journal of Engineering Education, 101*(2), 288-318.

Bridgeman, B., Pollack, J., & Burton, N. (2008). Predicting grades in college courses: A comparison of multiple regression and percent succeeding approaches. *Journal of College Admission,* (199), 19-25.

Brower, A. M. & Inkelas, K. K. (2010). living-learning programs: One high-impact educational practice we now know a lot about. *Liberal Education, 96*(2), 36-43.

Brown, J. L., Halpin, G., & Halpin, G. (2015). Relationship between high school mathematical achievement and quantitative GPA. *Higher Education Studies, 5*(6), 1-8.

Brown, S., Flick, L., & Fiez, T. (2009). An investigation of the presence and development of social capital in an electrical engineering laboratory (Vol. 98, pp. 93-103): ASEE.

Bureau of Labor Statistics, U. S. Department of Labor. (2014-2015 Edition). Occupational Outlook Handbook. Retrieved from http://www.bls.gov/ooh/architecture-and-engineering/home.htm.

Buse, K., Bilimoria, D., & Perelli, S. (2013). Why they stay: Women persisting in US engineering careers. *Career Development International, 18*(2), 139-154.

Cech, E. (2015). Engineers and engineeresses? Self-conceptions and the development of gendered professional identities. *Sociological Perspectives, 58*(1), 56.

Cech, E., Rubineau, B., Silbey, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering, 641.

Clark, A. (2015). Last women's college in N.J. goes co-ed [St. Elizabeth College goes co-ed]. Retrieved from http://www.nj.com/education/2015/06/njs_last_all-womens_college_to_admit_men.html

Clarke, R. J. G. (2011). Giving voice to student and alumnae opposition during the transition to coeducation by a college for women. ProQuest LLC, (870478950).

Cronin, C. (2014). Using case study research as a rigorous form of inquiry. *Nurse Researcher, 21*(5), 19-27. doi:10.7748/nr.21.5.19.e1240

Datnow, A., & Hubbard, L. (2002). *Gender in policy and practice: perspectives on single-sex and coeducational schooling*. New York, NY: Routledge Falmer.

Davis, K. S. (1999). Why science? Women scientists and their pathways along the road less traveled. *Journal of Women and Minorities in Science and Engineering, 5*(2), 129-153.

Derks, J., & Krabbendam, L. (2013). Is the brain the key to a better understanding of gender differences in the classroom? *International Journal of Gender, Science and Technology [Online], 5*(3), *281-291*.

Eccles, J. S., & Wang, M. (2016). What motivates females and males to pursue careers in mathematics and science?. *International Journal of Behavioral Development, 40*(2), 100. doi:10.1177/0165025415616201

Eccles, J. (2013). Gender and STEM: Opting in versus dropping out. *International Journal of Gender, Science and Technology, 5*(3), 184-186.

Eccles, J. (2011). Gendered educational and occupational choices: Applying the Eccles et al. model of achievement-related choices. *International Journal of Behavioral Development, 35*(3), 195-201.

Eccles [Parsons], J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectations, values and academic behaviors. In J. T. Spence (Ed.), *Perspectives on achievement and achievement motivation* (pp. 75-146). San Francisco, CA: W. H. Freeman and Company.

Ellertson, S., & Thoennes, K. V. (2007). Reframing teaching and learning: Lessons from learning communities for student affairs (pp. 35-47): Wiley-Blackwell.

Flore, P. C., & Wicherts, J. M. (2015). Does stereotype threat influence performance of girls in stereotyped domains? A meta-analysis. *Journal of School Psychology, 53*(1), 25-44. doi:10.1016/j.jsp.2014.10.002

Galdi, S., Cadinu, M., & Tomasetto, C. (2014). The roots of stereotype threat: When automatic associations disrupt girls' math performance. *Child Development, 85*(1), 250-263. doi:10.1111/cdev.12128

Ganley, C. M., Mingle, L. A., Ryan, A. M., Ryan, K., Vasilyeva, M., & Perry, M. (2013). An examination of stereotype threat effects on girls' mathematics performance. *Developmental Psychology, 49*(10), 1886-1897.

Garrett, M. D., & Zabriskie, M. S. (2004). The Influence of living-learning program participation on student-faculty interaction (Vol. 33, pp. 38-45): Association of College & University Housing.

Gaspard, H., Dicke, A. L., Flunger, B., Schreier, B., Häfner, I., Trautwein, U., & Nagengast, B. (2015). More value through greater differentiation: Gender differences in value beliefs about math. *Journal of Educational Psychology, 107*(3), 663-677. doi:10.1037/edu0000003

Glazer-Raymo, J. (2008). *Unfinished agendas: New and continuing gender challenges in higher education*: Johns Hopkins University Press.

Goan, S. K., Cunningham, A. F., & Carroll, C. D. (2006). *Degree completions in areas of* national need, 1996-97 and 2001-02. Retrieved from Institute for Higher Education Policy, Washington, D.C.

Goldin C., & Katz, L.F. (2011). Putting the “Co” in education: Timing, reasons, and consequences of college coeducation from 1835 to the present. *Journal of Human Capital, 5*(4), p. 377-417.

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology, 102*(4), 700-717. doi:10.1037/a0026659

Goulden, M., Frasch, K., & Mason, M. A. (2009). *Staying competitive: Patching America's leaky pipeline in the sciences*. Retrieved from Center for American Progress, Washington, DC.

Guo, J., Parker, P. D., Marsh, H. W., & Morin, A. J. S. (2015). Achievement, motivation, and educational choices: A Longitudinal study of expectancy and value using a multiplicative perspective. *Developmental Psychology, 51*(8), 1163-1176. doi:10.1037/a0039440.

Hall, R. M., & Sandler, B. R. (1982). *The classroom climate: A chilly one for women?* . Project on the Status and Education of Women. Association of American Colleges, Washington, DC. Retrieved from https://login.proxy.libraries.rutgers.edu/login?url=http://search.ebscohost.com.proxy.libraries.rutgers.edu/login.aspx?direct=true&db=eric&AN=ED215628&site=eds-live.

Harwarth, I., (1997). *Women's colleges in the United States: History, issues, and challenges*. National Institute on Postsecondary Education, Libraries and Lifelong Learning, Washington D. C.

Hill, C., Corbett, C., & St Rose, A. (2010). *Why so few?* Retrieved from http://www.aauw.org.

Hixenbaugh, P., Dewart, H., & Towell, T. (2012). What enables students to succeed? An investigation of socio-demographic, health and student experience variables. *Psychodynamic Practice, 18*(3), 285-301. doi:10.1080/14753634.2012.695887.

Hodge, J. Q., Lagoudas, M. Z., Harris, A. M., Froyd, J. E., Hobson, M., & Pope, J. A. (2011). *Influencing the academic success of undergraduate first-year engineering students through a living learning community*. Paper presented at the American Society for Engineering Education (ASEE) Annual Conference and Exposition, Vancouver, B.C. Canada. retrieved from www.scopus.com.

Hyun Kyoung, R., & Loya, K. I. (2015). The effect of gender and race intersectionality on student learning outcomes in engineering. *Review of Higher Education, 38*(3), 359.

Idema, A. G. (2010). An organizational theory approach to transition: The Wheaton College move to coeducation. ProQuest LLC, (816191995).

Inkelas, K. K. (2011). Living-learning programs for women in STEM. *New Directions for Institutional Research* (Vol. no. 152, Winter 2011, pp. 27-37). Wiley Online Library: Wiley Periodicals, Inc.

Inkelas, K. K., Daver, Z. E., Vogt, K. E., & Leonard, J. (2007). Living–learning programs and first-generation college students' academic and social transition to college. *Research in Higher Education, 48*(4), 403-434. doi:10.1007/s11162-006-9031-6

Inkelas, K. K., & Weisman, J. L. (2003). Different by design: An examination of student outcomes among participants in three types of living-learning program. *Journal of College Student Development*(3), 335.

Jansen, N., & Joukes, G. (2013). Long term, interrelated interventions to increase women's participation in STEM in the Netherlands. *International Journal of Gender, Science and Technology, 5*(3), 305-316.

Jensen, F., & Bøe, M. V. (2013). The influence of a two-day recruitment event on female upper secondary students' motivation for science and technology higher education. *International Journal of Gender, Science and Technology, 5*(3), 317-337.

Jessup-Anger, J. E., Johnson, B. N., & Wawrzynski, M. R. (2012). Exploring living-learning communities as a venue for men's identity construction (Vol. 38/39, pp. 162-176): Association of College & University Housing.

Johnson, W. G., & Cavins, K. M. (1996). Strategies for enhancing student learning in residence halls (pp. 69-83): John Wiley & Sons, Inc.

Jones, C., & Lyons, C. (2004). Case study: Design? Method? Or comprehensive strategy? *Nurse Researcher, 11*(3), 70-76.

Kahveci, A., Southerland, S. A., & Gilmer, P. J. (2008). From marginality to legitimate peripherality: Understanding the essential functions of a women's program. *Science Education, 92*(1), 33-64.

Kim, Y. K., & Sax, L. J. (2014). The effects of student-faculty interaction on academic self-concept: Does academic major matter? *Research in Higher Education, 55*(8), 780-809.

Langdon, E. (2001). Women's colleges then and now: Access then, equity now. *Peabody Journal of Education, (1)*5. http://www.jstor.org/stable/1493003

Lazarides, R., & Ittel, A. (2013). Mathematics interest and achievement: What role do perceived parent and teacher support play? A longitudinal analysis. *International Journal of Gender, Science and Technology, 5*(3), 207-231.

Lee, H. S., Flores, L. Y., Navarro, R. R., & Kanagui-Muñoz, M. (2015). A longitudinal test of social cognitive career theory's academic persistence model among Latino/a and White men and women engineering students. *Journal of Vocational Behavior, 88*, 95-103. doi:10.1016/j.jvb.2015.02.003

Legewie, J., & DiPrete, T. A. (2014a). Pathways to science and engineering Bachelor's degrees for men and women. *Sociological Science, 1*(February), 41-47. doi:10.15195/v1.a4

Legewie, J., & DiPrete, T. A. (2014b). The high school environment and the gender gap in science and engineering. *Sociology of Education, 87*(4), 259-280.

Lenning, O. T., & Ebbers, L. H. (1999). The powerful potential of learning communities: improving education for the future (Vol. 26, pp. 1-138): John Wiley & Sons, Inc.

Lewis, J. J. (2015). Seven sisters college history - historical background. Retrieved from http://womenshistory.about.com/od/educationhigher/ss/Seven-Sisters-Colleges-Historical-Background.htm

Litzler, E., Samuelson, C. C., & Lorah, J. A. (2014). Breaking it down: Engineering student STEM confidence at the intersection of race/ethnicity and gender. *Research in Higher Education, 55*(8), 810-832.

London, B., Rosenthal, L., & Gonzalez, A. (2011). Assessing the role of gender, rejection, sensitivity, identity, and support on the academic engagement of women in nontraditional fields using experience sampling methods. *Journal of Social Issues, 67*(3), 510-530. doi:10.1111/j.1540-4560.2011.01712.x

McGee, E., & Bentley, L. (2017). The troubled success of black women in STEM. *Cognition and Instruction, 35*(4), 265-289. doi:10.1080/07370008.2017.1355211

Marra, R. M., Rodgers, K. A., Shen, D., & Bogue, B. (2009). Women engineering students and self-efficacy: A multi-year, multi-institution study of women engineering student self-efficacy. *Journal of Engineering Education, 98*(1), 27.

Markus, H., & Wurf, E. (1987). The dynamic self-concept: A social psychological perspective. *Annual Review of Psychology, 38*(1), 299.

Matusovich, H. M., Streveler, R. A., & Miller, R. L. (2010a). How They See Themselves. ASEE Prism, 20(3), 47.

Matusovich, H. M., Streveler, R. A., & Miller, R. L. (2010b). Why do students choose engineering? A qualitative, longitudinal investigation of students' motivational values. *Journal of Engineering Education, 99*(4), 289-303.

Meadows, L. A., Nidiffer, J., Ball, S. R., Davis, C.-S. G., Finelli, C. J., & Schultz, W. W. (Oct 2006). *Work in progress: An initial assessment of the effect of the first year experience on under-represented student retention in engineering.* Paper presented at the Frontiers in Education Conference, 36th Annual.

Messina, J. A. (2011). *A statistical analysis of the impact of participation in living-learning communities on academic performance and persistence.* (Doctor of Education), University of Akron. (3492620)

Miller, C. C. (2013). Empowering girls to build the future. Retrieved from http://bits.blogs.nytimes.com/2013/11/20/a-viral-video-encourages-girls-to-become-engineers/?src=me&ref=general&_r=0.

Miller-Bernal, L. (1993). Single-sex versus coeducational environments: A comparison of women students' experiences at four colleges. (1), 23.

Miller-Bernal, L. (2000). *Separate by degree: Women students' experiences in single-sex and coeducational colleges*. New York: Peter Lang International Academic Publishers.

Miller-Bernal, L. (2008). Changes in the status and function of women's colleges over time. In J. H. Ballantine & J. Z. Spade (Eds.), *Schools and society: A sociological approach to education*. California: Sage Publications, Inc.

Morella, M., & Kurtzleben, D. (2013). The state of STEM (Vol. 5, pp. 11-12): US News & World Report, L.P.

Morgan, S. L., Gelbgiser, D., & Weeden, K. A. (2013). Feeding the pipeline: Gender, occupational plans, and college major selection. *Social Science Research, 42*, 989-1005. doi:10.1016/j.ssresearch.2013.03.008

Morris, L. K. (2003). *The chilly climate for women: A literature review*. Retrieved from https://login.proxy.libraries.rutgers.edu/login?url=http://search.ebscohost.com.proxy.libraries.rutgers.edu/login.aspx?direct=true&db=eric&AN=ED482555&site=eds-live.

Musu-Gillette, L. E., Wigfield, A., Harring, J. R., & Eccles, J. S. (2015). Trajectories of change in students' self-concepts of ability and values in math and college major choice. *Educational Research and Evaluation, 21*(4), 343-370, doi:10.1080/13803611.2015.1057161.

National Center for Education Statistics (1995). *Digest of education statistics*. Retrieved from U.S. Department of Education: http://nces.ed.gov/programs/digest/d95/dtab233.asphttp://nces.ed.gov/programs/digest/d13/tables/dt13_317.10.asp.

National Center for Education Statistics (2013). *Digest of education statistics* (NCES 2014-015). Retrieved from U.S. Department of Education: http://nces.ed.gov/fastfacts/display.asp?id=84.

National Science Foundation (2018). *Science and engineering indicators 2018: Higher education in science and engineering.* Appendix Table 2-36. Retrieved from nsf.gov: https://www.nsf.gov/statistics/2018/nsb20181/report/sections/higher-education-in-science-and-engineering/international-s-e-higher-education.

National Science Foundation (2017). *Science and engineering indicators 2017: Higher education in science and engineering*. Retrieved from nsf.gov: https://www.nsf.gov/statistics/2017/nsf17310/data.cfm.

National Science Foundation (2016). *National Science Board: Science and engineering indicators 2016.* Retrieved from nsf.gov: https://www.nsf.gov/statistics/2016/nsb20161/uploads/1/nsb20161.pdf. https://www.nsf.gov/statistics/2016/nsb20161/#/report/chapter-2/international-s-e-higher-education/first-university-degrees-in-s-e-fields.

National Science Foundation (2014). *Science and engineering indicators 2014: Higher education in science and engineering*. Retrieved from nsf.gov: http://www.nsf.gov/statistics/seind14/content/chapter-2/chapter-2.pdf.

National Science Foundation (2013). *Women, minorities, and persons of disabilities in science and engineering.* Retrieved from Arlington, Virginia: http://www.nsf.gov/statistics/wmpd/2013/.

National Science Foundation (2012). *Science and engineering indicators 2012: Higher education in science and engineering*. Retrieved from nsf.gov: http://www.nsf.gov/statistics/seind12/pdf/c02.pdfhttp://www.nsf.gov/statistics/seind12/c2/c2s2.htm.

National Student Clearinghouse Research Center (Winter 2015). *Snapshot report: Degree attainment 2004-2014*. Retrieved from http://nscresearchcenter.org/wp-content/uploads/SnapshotReport15-DegreeAttainment.pdf.

Neuville, E., & Croizet, J.-C. (2007). Can salience of gender identity impair math performance among 7-8 years old girls? The moderating role of task difficulty. *European Journal of Psychology of Education - EJPE (Instituto Superior de Psicologia Aplicada), 22*(3), 307-316.

Nidiffer, J. (2007). When I went to college is now considered history! American women's participation in higher education in the twentieth century. *History of Education Quarterly, 47*(3), 377-388.

Niederle, M., & Vesterlund, L. (2010). Explaining the gender gap in math test scores: The role of competition. *Journal of Economic Perspectives, 24*(2), 129-144. doi:http://www.aeaweb.org.proxy.libraries.rutgers.edu/jep/.

Olden, K., Ramos, R. M., & Freudenberg, N. (2009). To reduce urban disparities in health, strengthen and enforce equitably environmental and consumer laws. *Journal Of Urban Health: Bulletin of The New York Academy Of Medicine, 86*(6), 819-824. doi:10.1007/s11524-009-9380-5.

Pace, D., Witucki, L., & Blumreich, K. (January 4, 2008). Benefiting female students in science, math, and engineering: The nuts and bolts of establishing a WISE (Women in Science and Engineering) learning community. *NASPA Journal (Online), 45*(3), 373-384.

Parker, L. (March 2004). *The education and employment of engineering graduates* (Report # 1). Retrieved from Cambridge, MA: http://www.nspe.org/sites/default/files/resources/pdfs/blog/Abt-Report-on-Engineering-Profession1.pdf

Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students: A third decade of research*. San Francisco: Jossey-Bass.

Penven, J., Stephens, R., Shushok Jr, F., & Keith, C. (2013). The past, present, and future of residential colleges: Looking back at S. Stewart Gordon's Living and Learning in College (Vol. 39/40, pp. 114-127): Association of College & University Housing.

Pike, G. R., Kuh, G. D., & McCormick, A. C. (2011). An investigation of the contingent relationships between learning community participation and student engagement (Vol. 52, pp. 300-323): Springer Science & Business Media B.V.

Pollack, E. (October 3, 2013, October 3, 2013). Why are there still so few women in science? *New York Times,* p. 10. Retrieved from http://www.nytimes.com/2013/10/06/magazine/why-are-there-still-so-few-women-in-science.html?_r=2&adxnnl=1&ref=general&src=me&pagewanted=1&adxnnlx=1382035816-8aU38CU5dwQ%2FCogjk8BrBw#commentsContainer.

Pronin, E., Lin, D., & Ross, L. (2002). The bias blind spot: Perceptions of bias in self versus others. Personality and Social Psychology Bulletin, 28(3), 369-381. doi:10.1177/0146167202286008.

Pryor, J. H., Eagan, K., Palucki Blake, L., Hurtado, S., Berdan, J., & Case , M. H. (2012). *The American freshman: National norms fall 2012*. Retrieved from UCLA, California: http://www.heri.ucla.edu.proxy.libraries.rutgers.edu/monographs/TheAmericanFreshman2012-Expanded.pdf.

Purdie II, J. R., & Rosser, V. J. (2011). Examining the academic performance and retention of first-year students in living-learning communities and first-year experience courses (Vol. 29, pp. 95-113): Information Age Publishing.

Richman, L. S., vanDellen, M., & Wood, W. (2011). How women cope: Being a numerical minority in a male-dominated profession. *Journal of Social Issues, 67*(3), 492-509. doi:10.1111/j.1540-4560.2011.01711.x.

Riegle-Crumb, C., King, B., Grodsky, E., & Muller, C. (2012). The more things change, the more they stay the same? Prior achievement fails to explain gender inequality in entry into STEM college majors over time. *American Educational Research Journal, 49*(6), 1048-1073.

Riney, M. R., & Froeschle, J. (2012). Socialization processes of engineering students: Differences in the experiences of females and males. *Administrative Issues Journal: Education, Practice, And Research, 2*(1), 96-106.

Riordan, C. (1990). *Girls and boys in school: Together or separate?* New York and London: Teachers College Press.

Riordan, C. (1994). The value of attending a women's college: Education, occupation, and income benefits. *Journal of Higher Education, 65*,486-5.

Robnett, R. (2013). The role of peer support for girls and women in STEM: Implications for identity and anticipated retention. *International Journal of Gender, Science and Technology, 5*(3), 178.

Robnett, R. D., & Thoman, S. E. (2017). STEM success expectancies and achievement among women in STEM majors. *Journal of Applied Developmental Psychology, 52*, 91-100. doi:10.1016/j.appdev.2017.07.003.

Rocconi, L. M. (March 2011). The impact of learning communities on first year students' growth and development in college. *Research in Higher Education, 52*, 178-193. doi:10.1007/s11162-010-9190-3.

Rutgers University (2014a). Rutgers History. Retrieved from https://www.rutgers.edu/about-rutgers/rutgers-history.

Rutgers University (2014b). Rutgers University Fact Book. Retrieved from https://oirap.rutgers.edu/instchar/Factbook_PDFs/2014/1-lrAdmit2014-

section%201.pdf.

Rutgers University (2015a). About Rutgers: Points of pride. Retrieved from https://www.rutgers.edu/about-rutgers/points-pride.

Rutgers University (2015b). Facts and figures. Retrieved from http://newbrunswick.rutgers.edu/about/facts-figures.

Rutgers University, School of Engineering (2014). Facts and figures. Retrieved from http://soe.rutgers.edu/facts-and-figures.

Rutgers University, School of Engineering (2017). Departments and programs. Retrieved from http://soe.rutgers.edu/departments-and-programs.

Rutgers University (2014). *Engineering at Rutgers: Meet Angel Mathew* Retrieved from http://www.youtube.com/watch?v=Y6dd3HHTRMM.

Sadker, D., Sadker, M., & Zittleman, K. R. (2009). *Still failing at fairness: How gender bias cheats girls and boys in school and what we can do about it* New York: Scribner

.

Samuelson, C., Staples, C. L., Smith, P. E., Amelink, C. T., & Litzler, E. (2014). Living, learning, and staying: The impact of a women in engineering living and learning community. Proceedings of the ASEE Annual Conference & Exposition, 1.

Sax, L., Allison Kanny, M., Jacobs, J., Whang, H., Weintraub, D., & Hroch, A. (2016). Understanding the changing dynamics of the gender gap in undergraduate engineering majors: 1971-2011. *Research In Higher Education, 57*(5), 570-600. doi:10.1007/s11162-015-9396-5.

Schmidt, G. P. (1968). Douglass College: A History. New Brunswick, New Jersey: Rutgers University Press.

Seifert, T. A., Gillig, B., Hanson, J. M., Pascarella, E. T., & Blaich, C. F. (2014). The conditional nature of high impact/good practices on student learning outcomes. *Journal of Higher Education, 85*(4), 531-564.

Semel, S. F. (1994). Writing school history as a former participant: problems in writing the history of an elite school. In G. Walford (Ed.), Researching the Powerful in Education (pp. 204-220): University College London Press.

Semel, S. F. (Fall 1995). Writing history as a former participant: Reflections on the connections between autobiography and history. [invited general-adapted from Semel, 1994]: Hofstra Horizons.

Settles, I. H., Buchanan, N. T., Cortina, L. M., & Miner, K. N. (2013). Derogation, discrimination, and (dis)satisfaction with jobs in science: A gendered analysis. *Psychology of Women Quarterly, 37*(2), 179-191. doi:10.1177/0361684312468727.

Seymour, E., & Aikenhead, G. S. (1995). The loss of women from science, mathematics, and engineering undergraduate majors: An. *Science Education, 79*(4), 437.

Seymour, E., Hewitt, N. M., & Alfred, P. S. F. (1994). Talking about leaving.

Shapiro, C. A., & Sax, L. J. (2011). Major selection and persistence for women in STEM. *New Directions for Institutional Research, 152,* 5-18. doi:10.1002/ir.404.

Shapiro, J. R., & Williams, A. M. (2012). The role of stereotype threats in undermining girls' and women's performance and interest in STEM fields. *Sex Roles, 66*(3-4), 175-183.

Sheppard, S., Atman, C., Fleming, L., Miller, R., Smith, K., Stevens, R., Steveler, R., Clark, M., Loucks-Jaret, T., Lund, D. (2010). An overview of the academic pathways study: Research processes and procedures. Technical Report #CAEE-TR-09-03. Summer 2003-Fall 2008. University of Washington, Center for the Advancement of Engineering Education (CAEE). 3C 26-32.

Shushok, F., & Sriram, R. (2009). Exploring the effect of a residential academic affairs-student affairs partnership: The first year of an engineering and computer science living-learning center (Vol. 36, pp. 68-82): Association of College & University Housing.

Simpson, A. (1971). Coeducation at Vassar. College Board Review.

Snyder, T. D., Dillow, S. A., & National Center for Education, S. (2013). *Digest of Education Statistics, 2012. NCES 2014-015 [Appendix A: Guide to sources; Appendix B: Definitions; Appendix C: Index of table numbers]*. Retrieved from https://login.proxy.libraries.rutgers.edu/login?url=http://search.ebscohost.com.proxy.libraries.rutgers.edu/login.aspx?direct=true&db=eric&AN=ED544579&site=eds-live.

Soldner, M., Rowan-Kenyon, H., Kurotsuchi Inkelas, K., Garvey, J., & Robbins, C. (2012). Supporting students' intentions to persist in STEM disciplines: The role of living-learning programs among other social-cognitive factors. *Journal of Higher Education, 83*(3), 311-336.

Sonnert, G., & Fox, M. F. (2012). Women, men, and academic performance in science and engineering: The gender difference in undergraduate grade point averages. *Journal of Higher Education, (1)*83, 73-102.

Stassen, M. L. A. (2003). Student outcomes: The impact of varying living-learning community models. *Research in Higher Education, 44*(5), 581-613.

Stebleton, M., & Nownes, N. (2011). Writing and the world of work: An integrative learning community model at a two-year institution (Vol. 41, pp. 76-87): College Reading & Learning Association.

Steele, C. M. (April 1992). Race and the schooling of black Americans. *Atlantic, 269,* 68-78.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*(5), 797-811.

Szelényi, K., Denson, N., & Inkelas, K. K. (2013). Women in STEM majors and professional outcome expectations: The role of living-learning programs and other college environments. *Research in Higher Education, 54*(8), 851-873. doi:10.1007/s11162-013-9299-2.

Tai, R. H., Qi Liu, C., Maltese, A. V., & Fan, X. (2006). Career choice. Planning early for careers in science. *Science (New York, N.Y.), 312*(5777), 1143-1144.

Thoman, D. B., Arizaga, J. A., Smith, J. L., Story, T. S., & Soncuya, G. (2014). The grass is greener in non-science, technology, engineering, and math classes: Examining the role of competing belonging to undergraduate women's vulnerability to being pulled away from science. *Psychology of Women Quarterly, 38*(2), 246-258.

Tidball, M. E., Smith, D. G., Tidball, C. S., & Wolf-Wendel, L. E. (1999). *Taking women seriously: Lessons and legacies for educating the majority*. Washington, D.C.: American Council on Education/Oryx Press Series on Higher Education.

Tomasetto, C., Alparone, F. R., & Cadinu, M. (2011). Girls' math performance under stereotype threat: The moderating role of mothers' gender stereotypes. *Developmental Psychology, 47*(4), 943-949. doi:10.1037/a0024047.

Tong, R. (2014). *Feminist thought: A more comprehensive introduction*. Boulder: Westview Press.

U.S. Census (2010). Table 278. Higher education—institutions and enrollment 1980 to 2009. Census: U.S. Government.

U.S. Department of Education, National Center for Education, Integrated Postsecondary Education Data. (2013). Actual and projected numbers for total enrollment in all postsecondary degree-granting institutions, by sex, attendance status, and control of institution: Fall 1996 through fall 2021 (pp. table of enrollment in higher education 2000-2021 by gender and public versus private). U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data.

U.S. Department of Education, National Center for Education (August 2000). *Entry and persistence of women and minorities in college science and engineering education*. Retrieved from Washington, D.C.: http://nces.ed.gov/pubs2000/2000601.pdf.

Vest, J. L., Goldberg, J. L., & Solace, W. E. (1996). *Involving students through building community: Challenges for women in engineering programs*. Retrieved from Maryland: https://login.proxy.libraries.rutgers.edu/login?url=http://search.ebscohost.com.proxy.libraries.rutgers.edu/login.aspx?direct=true&db=eric&AN=ED398858&site=eds-live.

Vogt, C. M., However, D., & Haledon, L. S. (2007). A social cognitive construct validation: Determining women's and men's success in engineering programs. *Journal of Higher Education, 78*(3), 337-364.

Waldron, V. R., & Yungbluth, S. C. (2007). Assessing student outcomes in communication-intensive learning communities: A two-year longitudinal study of academic performance and retention. *Southern Communication Journal, 72*(3), 285-302. doi:10.1080/10417940701484233.

Walton, G. M., Loge, C., Peach, J. M., Spencer, S. J., & Zane, M. P. (2014). Two brief interventions to mitigate a chilly climate transform women's experience, relationships, and achievement in engineering. *Journal of Educational Psychology*. doi:10.1037/a0037461.

Wang, X. L. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal, 50*(5), 1081-1121.

Watt, H. M. G., Jansen, N., & Joukes, G. (2013). Editorial: Gendered pathways towards (and away from) STEM fields. *International Journal of Gender, Science and Technology, 5*(3), 178-183.

Watt, H. M. G., Richardson, P. W., & Davos, C. (2013). (How) Does gender matter in the choice of a STEM teaching career and later teaching behaviours? *International Journal of Gender, Science and Technology, 5*(3), 187-206.

Women's College Coalition (2015). Discover: The truth about women's colleges. Retrieved from http://www.womenscolleges.org/discover/reports/truth-about-womens-colleges.

Xu, Y. J. (2017). Attrition of women in STEM. Journal of Career Development (Sage Publications Inc.), 44(1), 3. doi:10.1177/0894845316633787.

Yin, R. K. (2013). Case Study Research: design and methods: SAGE.

Yonghong, X. (2015). Focusing on women in STEM: A longitudinal examination of gender-based earning gap of college graduates. *Journal of Higher Education, 86*(4), 489-523.

Young, D. M., Rudman, L. A., Buettner, H. M., & McLean, M. C. (2013). The influence of female role models on women's implicit science cognitions. *Psychology of Women Quarterly, 37*(3), 283-292. doi:10.1177/0361684313482109.

Zhao, C.-M., & Kuh, G. D. (2004). Adding value: learning communities and student engagement. *Research in Higher Education, 45*(2), 115-138.

Zundl, E., Stiltz, L., & Buettner, H. M. (June 2015). *Understanding the relationship between living-learning communities and self-efficacy of women in engineering*. Paper presented at the 122nd ASEE Annual Conference & Exposition, Seattle, WA.

Appendix A

Protocol for individual interviews for students in the Douglass Engineering Living-Learning Community

Overview

I am conducting interviews with students who have joined the Douglass Engineering Living Learning Community (REILLY - DELLC). All respondents will be asked questions regarding their experiences in REILLY – DELLC and in their Engineering/STEM classes.

Questions are designed to elicit student perceptions of experiences in the Reilly-Douglass Engineering Living-Learning Community. This includes recruitment and retention questions. All interviews will take place between March and May 2016. Each interview will last up to 90 minutes.

Introductory Comments

"I would first like to start by welcoming you and thanking you for participating in this study. The purpose of this study is to gain a better understanding of the Douglass Engineering Living-Learning Community. As the consent form explains, you have been chosen for this interview because you are enrolled in the School of Engineering and joined the Douglass Engineering Living-Learning Community. I am really interested in how your experiences in REILLY – DELLC have been related to your major. I will be asking you questions about your experiences. I encourage you to answer to the best of your ability. There are no right or wrong answers. If at any point you become distressed, you can discontinue your participation in the session."

Statement of Confidentiality

"I will be tape recording this session in an effort to maintain the integrity of your dialogue. However, your identity will remain confidential and only I, as the researcher will have access to this tape. This discussion is confidential and any information will be used solely for research purposes."

Introduction: who I am and purpose of the interview.

- Interview will last approximately 90 minutes.
- I am interested in your experiences at Rutgers and in the Douglass community.
- I'm most interested in ***your*** ideas, opinions, and experiences both in and out of the Reilly DELLC.
- I appreciate whatever you are able to tell me about the topics I'll be exploring with you.

1. Let's start by talking a bit about your time in high school
    a. Where did you go to high school?
    b. Was that a specialized high school?
    c. How would you describe yourself as a student in high school?

d. How would you describe your preparation (from High School) in mathematics and science?

2. Can you tell me how you became interested in Engineering?
    a. What were some experiences that were important in sparking your interest in engineering?
    b. Was there anyone in your life who encouraged your interest in engineering? Who?)

3. Thinking about yourself before you came to Rutgers, how prepared did you think you were to succeed in engineering?

4. Can you tell me how and why you decided to come to Rutgers?

5. Why did you join the Douglass Engineering community? What did you expect to gain?

6. Had you thought about living in an all-female community before finding out about the Douglass Living-Learning Community?

7. Was it ***your*** decision entirely to join the Douglass community? Did anyone influence your decision (parents, guidance counselor, etc.)

8. In general, can you tell me what goals are most important to you (if prompting is needed, such as:
    a. Helping others in difficulty
    b. Influencing social values
    c. Helping promote racial understanding
    d. Participation in a community action program
    e. Becoming involved in programs about the environment

9. I'd like to ask about your classes since you've been here
    a. How would you describe your academic experiences
    b. (Use the good and bad as probes if you need them to elaborate)

10. Have you had much contact with non-engineering students? Would you say that there are things that distinguish engineering students from other majors?

11. I asked earlier to describe the student you were in high school. How would you describe the student you are now?

12. Let's talk a little about your experiences in the Engineering program, in general.

13. Which engineering major did you choose?

14. Is there anything that helped you make that choice?

15. Have you participated in any optional programs or events at Rutgers, related to Engineering that you particularly enjoyed, or you thought were particularly helpful? (Please explain.)

16. Let me ask you about other engineering students you have come across here.
    a. For now, focus on those only in the Douglass community. Would you say that they are more different from you for more similar?
    b. What about other women engineering students who were not in the Douglass community? Would you say they are more similar or more different from you? In what way?
    c. Now, think of the male engineering students in what ways do you believe they are similar or different?

17. Has anything surprised you about your classes?

18. Describe your experience in the Douglass Community

19. Has anything surprised you about being in the Douglass Community?

20. What has been easies for you in the engineering program?

21. What have you found the most difficult in the engineering program?

    a. How have you handled that?

22. Was there a point that you considered leaving the engineering major? Can you tell me about that?

23. What do you think makes you 'stick with it' when things get difficult?

24. Are there groups that you became a part of since coming here?
    a. Tell me more about that
    b. What role has <this group> played in your education
    c. IF NOT the DOUGLASS community, then ask the same questions (a & b) about the Douglass community.

25. Can you describe the strengths and weaknesses of living in the Douglass Engineering Community?

26. What do you think is the most important aspect of living in the Douglass Engineering Community?

27. Do you think you would get that if you were not in "the community?"

28. Regarding the common Engineering course that was part of your living-learning experience, can you tell me about that experience?

29. I know that you had ***that*** class in common, but in addition to that class, did you have any other courses where other students from the Douglass were in your class? If so, which classes?

30. Did you find that you took courses with other people in your residence hall? If so, were the courses in your major? If not, which courses?

31. Who did you typically study with? (were they in the DRC community?)

32. Did you include students who do not live in your residence hall in any study groups or activities? If so, was it a co-educational group?

33. How would you describe the relationships that you formed with people who lived on your floor, especially in the first year, versus other relationships.

34. I'd like to ask you to think about your three closest friends in college. How did you become friends with them?

    a. (If they were NOT part of the DRC engineering community), how would you describe your relationship with those in the Douglass engineering living-learning community?

35. How would you describe the relationships that you formed in the Douglass Living-learning Community versus other relationships?

36. Think about your professors here.

    a. Did you feel connected to any of the professors you had here? If so, what class(s)/discipline did they teach?
    b. Were any of the professors a role model to you? If so, who and why?
    c. Were any of the professors a role model for engineering? If so, who and why?
    d. What would you say she/he would think it means to be a good engineer?

37. Is there someone who has acted as a mentor to you in engineering? (if so, who)

38. I'm interested in knowing more about the other students in your engineering classes. How many male versus female students are in your engineering or math classes (about how many total students in a class)?

39. Knowing what you know now, as you look back on the time that you've been here, is there anything you would do differently?

40. One of the things that I'm interested in is diversity in engineering and engineering education in terms of race, ethnicity and gender. I'd like to ask you some questions related to this:
    a. Can you tell me how you identify racially and ethnically?
    b. Are there supports or barriers for you as a <ethnic identification> engineering student?
    c. How about people of other racial or ethnic groups?
    d. Do you think that there are differences between the experiences of male and female engineering students?
    e. How as it been for you here as a women engineering student?
    f. Can you describe how man and female students are treated? (follow-up if they are treated differently).

41. So, you are about to graduate
    a. What's next for you?
    b. What are you concerned about?

42. When you begin to work, do you think that it will be in Engineering? If yes, what do you think is the biggest factor affecting your decision to persist in Engineering.

43. What do you say it takes to be a good engineer (or other career if student indicates something different that they are doing after college)

44. Are there things about yourself that you would need to work on to become a successful (*engineer or what the student stated they were going to become*)

45. Has your experience in college pretty much what you expected, or is it different in some ways from what you had envisioned? Please explain.

46. Here's a scenario, There is a high school student who's interested in pretty much the same things you were interested in high school. The student comes to you for advice. Knowing what you now know what advice would you give them?

47. If you could whisper in the ear of the people who set up the Douglass Engineering Living-Learning Community here, what advice would you give them about the community?

48. What has been the best part of your experience in the Douglass engineering community? What is the worst?

49. Is there anything that I haven’t asked you about that you think I should?

50. Do you have any questions that you would like to ask me?

Appendix B

Table 1. Overall High School GPA by Student Type

Multiple Comparisons

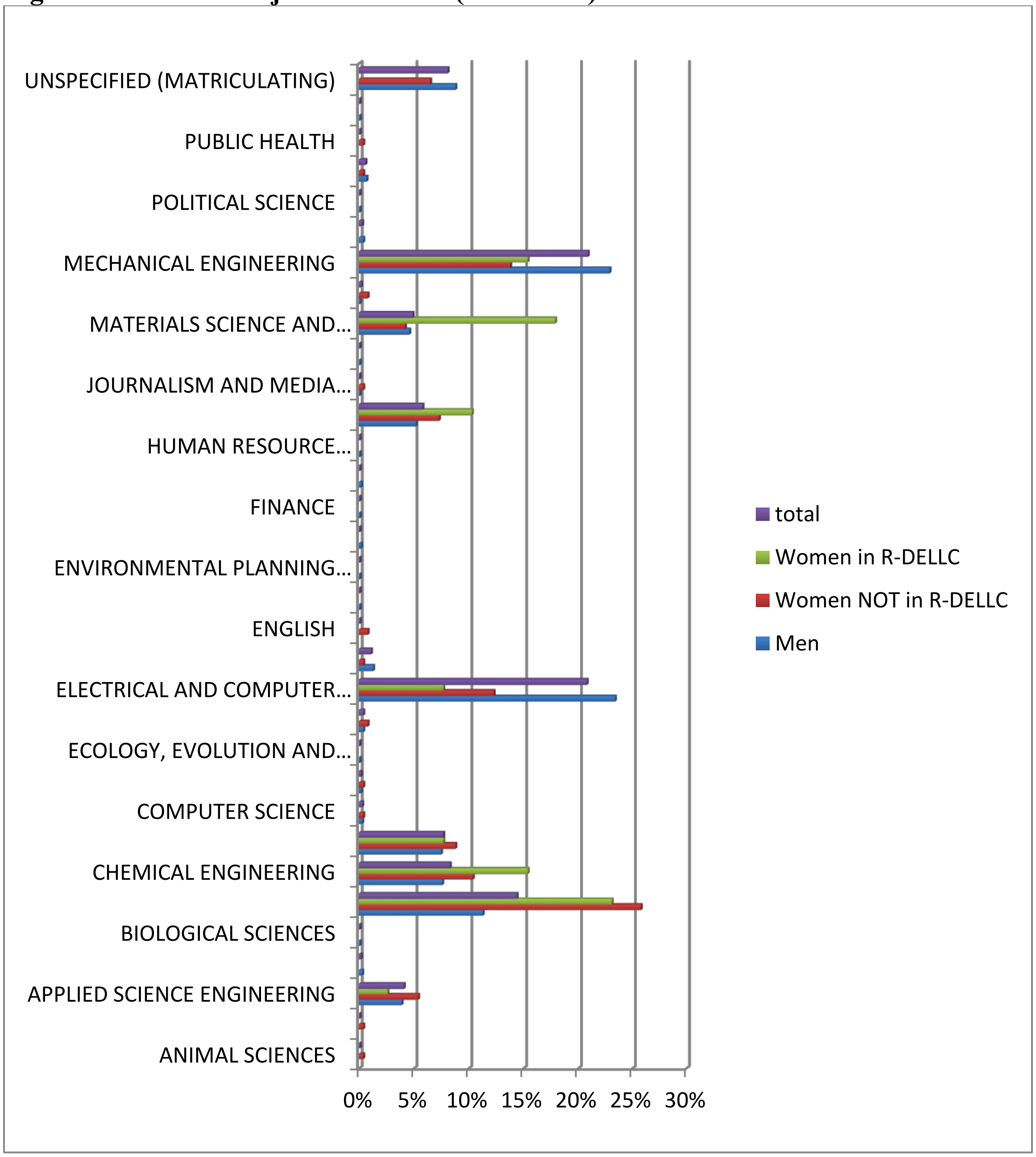
Dependent Variable: Overall Converted High School Grade Point Average
LSD

(I) Student type	(J) Student type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Men	Women NOT in R-DELLC	-.146*	.016	.000	-.18	-.11
	Women in R-DELLC	-.173*	.034	.000	-.24	-.11
Women NOT in R-DELLC	Men	.146*	.016	.000	.11	.18
	Women in R-DELLC	-.027	.036	.454	-.10	.04
Women in R-DELLC	Men	.173*	.034	.000	.11	.24
	Women NOT in R-DELLC	.027	.036	.454	-.04	.10

*. The mean difference is significant at the 0.05 level
F=50.602 (p=0.000)

Appendix C

Figure 1. Student Majors Year Two (2012-2015)



Appendix D

Description of Engineering Majors
in the School of Engineering, Rutgers University-New Brunswick

(program descriptions obtained from http://soe.rutgers.edu/departments-and-programs)

Applied Sciences Engineering: Applied Sciences is an individualized interdisciplinary program. Applied sciences is intended to provide a broad set of engineering knowledge not covered by one of the other majors at Rutgers University-New Brunswick School of Engineering. Possible concentrations include: packaging engineering, engineering physics, operations research, IT, and premed (note: a premed curriculum can be completed along with any other engineering major). Other fields may be added to meet the special interests of engineering students. This major is not professionally accredited.

Bioenvironmental Engineering: Bioenvironmental engineering integrates the principles of engineering and biotechnology along with the physical, chemical and biological sciences to help solve human-related environmental issues. This includes ways to improve public health, applications for recycling and waste disposal, addressing water and air pollution, and other issues affecting the natural environment. Bioenvironmental engineers may work in a variety of environmental engineering fields such as: air pollution control, bioremediation, environmental health and safety, hazardous waste management, site remediation, solid waste management, renewable energy generation, storm water treatment, and water and wastewater treatment.

<u>Biomedical Engineering</u>: By converging engineering, design, and human health, biomedical engineers develop the devices and equipment that improve the quality of life for millions of people. Biomedical engineers design prostheses, artificial organs and pharmaceutical products that directly improve quality of life for millions of people. They also design and manufacture diagnostic and therapeutic devices and imaging equipment that give doctors and medical researchers the tools to identify and treat a wide range of illnesses and injuries. A career in biomedical engineering is an excellent option for someone interested in medicine, but who may prefer working behind the scenes rather than directly with patients. I

<u>Chemical and Biochemical Engineering</u>: Chemical engineers apply principles of chemistry, biology, and physics in a wide range of fields including alternative energy, waste management, pharmaceuticals, agriculture and food products, automotive, and consumer goods. Biochemical engineering is a branch of chemical engineering that involves similar training, but focuses on living organisms. Chemical and biochemical engineers advance innovation and discovery through technology and physical and life sciences, leaving their imprint on a broad array of industries. Their work can range from the luxurious like developing softer clothes or better cosmetics to the lifesaving like producing fire-resistant materials or safer food. Chemical engineers might conduct cutting-edge pharmaceutical research, discover how to extend the shelf life of antibiotics, or be part of a creative team at a food company concocting a new candy bar.

Civil and Environmental Engineering: Civil engineers design and create virtually all infrastructures, from bridges and highways to airports and sewage treatment facilities. Within civil engineering, there can a be a wide range of specialization: structural engineers may be involved in designing buildings to withstand earthquakes and hurricanes; transportation engineers may design highways; construction and geotechnical engineers may be involved with creating new towers and tunnels. Civil and environmental engineers contribute to the development of a more sustainable infrastructure and environment.

Electrical and Computer Engineering: Electrical and computer engineering is a rapidly developing field spanning communications, information processing, and micro- and nano- electronics. Electrical engineers are in the forefront of technology that continually transforms our rapidly changing world. From developing advanced navigation systems and self-piloted vehicles to designing "smart" homes and cyber security systems, electrical and computer engineers have a profound impact on how we live and how society will continue to progress for generations to come.

Industrial and Systems Engineering: Industrial and systems engineering focuses on the design, installation, and integration of people, materials, equipment, and energy in an expansive range of industries. Industrial engineers devise ways to make products and services better, safer, easier to use, less expensive and more energy efficient. Whether it's shortening the wait time for a rollercoaster, streamlining operations in a hospital or getting products into the marketplace quicker and cleanlier, industrial engineers deliver solutions

Materials Science and Engineering: Generating new materials and new applications to meet the needs of industry and society, materials engineers study the interplay of materials' structure, performance, properties and synthesis. They develop materials like ceramics, metals, polymers, and composites that other engineers need for their designs. They might use plastics and other disposable materials to develop high-performance fabrics or redesign a compound's atomic crystal structure to create stronger, lighter body armor, or develop carbon nanotubes as a material to help sense bacteria, chemicals, and other dangers in our food and water supply.

Mechanical Engineering: Driving industry through the design, production and manufacture of mechanical systems, mechanical engineering is the most broad-based, extending its reach into a wide range of industries, including automotive, aerospace, industrial machinery, manufacturing, mining, oceanographic, petroleum, pharmaceutical, power, printing, and textiles. Virtually every object around us has passed through the hands of a mechanical engineer. MEs can be involved in designing and creating things as diversified as roller coasters, bomb squad robots, wind turbines, human implants, hybrid vehicles, communication satellites and amphibious sport planes.

Packaging Engineering Program: Packaging engineering is a multi-disciplinary field, within the Applied Sciences in Engineering major draws on chemical, industrial, materials, and mechanical engineering in order to design and create boxes, cartons, bottles, and other packing materials that meet specific criteria. Packaging engineers typically collaborate with colleagues in research and development, manufacturing, marketing, graphic design, and regulatory departments to address technical and marketing challenges. From manufacturer to consumer, the success of every package demands the skills of a multidisciplinary specialist. On supermarket shelves, in toy stores, drugstores and in warehouses, most people are interested in the products available and not so much in their containers. Manufacturers have specific requirements for a product's packaging: it may need to withstand certain temperatures, be a shape, be tamper-resistant, contain a pump capable of releasing a fine mist, or have other properties.