A Unique Co-curricular Partnership: The Douglass Engineering Living-Learning Community Inspires Women to Succeed

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Abstract - **The Douglass Engineering Living-Learning Community at Rutgers University is a new and unique opportunity for first-year women majoring in engineering. This partnership between Douglass Residential College and the Rutgers School of Engineering, which finishes its inaugural year this May, provides first-year women in engineering the opportunity to live on a floor together in a residence hall dedicated to only students studying engineering. Through this program students live, learn, and connect to an active academic and social network designed to ease the transition to Rutgers and facilitate success in engineering through mentoring and hands-on learning. Components of this program include peer support in-residence through the Douglass PAL (Peer Academic Leader) program, professional development workshops, interaction with and advising from a graduate mentor, and academic support through study groups and tutoring. In addition, all students participating in this community enroll in two required courses: a women's leadership course offered by Douglass Residential College in their fall semester and an exclusive section of the Engineering Exploration course offered by the School of Engineering for the women in this community during the spring semester. Through both of these courses, students interact with engineering faculty and professionals to empower them to become fully integrated into the greater engineering community.**

Index Terms - First-year experience, Living-learning communities, Women in engineering

INTRODUCTION

In 2009 President Barak Obama launched the Educate to Innovate initiative to promote increased success for American students in science, technology, engineering, and mathematics (STEM). One aspect of this program focuses on increasing the diversity of those participating in STEM fields, including expanding the number of women and girls exposed to and excited about entering the STEM workforce [1]. At the time of the President's announcement, the National Science Foundation had reported that although women represent 50% of the population in the United States, only 24% of them work in a STEM field nationally [2]. At Rutgers University, women follow a similar trend and represent less than 30% of the students enrolled in the School of Engineering at the undergraduate level.

Numerous studies have examined why women are underrepresented in science and engineering and have developed several different theories. One study found that female engineering students lack "professional role confidence" [3], while another describes stereotypes against women as scientists and the "Old Boys' Club" culture in college and university science and engineering departments at as reasons why women drop out of STEM fields [4]. Because increasing the number of women in STEM fields is a national issue, many colleges and universities have decided to intentionally focus on recruiting women to study engineering as well as supporting those who decide to enroll in the engineering curriculum.

One intervention these institutions have started using to encourage more women in science and engineering are living-learning communities [5]. Living-learning communities, or LLCs, incorporate academically-based themes in a residential building to promote community development through common learning, and provide women at colleges and universities with a high-impact experience as they study engineering [5]-[7]. Many schools of similar classification to Rutgers University have found this program to be successful in promoting and retaining women in engineering [5]-[7]. Thus, in 2011, Rutgers University decided to launch the Douglass Engineering Living-Learning Community as a way to encourage women in engineering.

Douglass Residential College, founded as the New Jersey College for Women, integrated completely into Rutgers University several years ago, opening the door for every woman at the University, regardless of major, to have access to a same-sex, co-curricular experience. Douglass prides itself on providing women at Rutgers with unique opportunities for leadership and professional growth though a variety of programs, including a collection of living-learning communities and a first-year common course on women's leadership. Further, the Douglass Project for Rutgers Women in Math, Science, and Engineering, founded 26 years ago at Douglass College, specializes in supporting

women in every STEM field through advising, mentoring, programming, and undergraduate research opportunities.

The Rutgers School of Engineering also supports women in engineering through the Women in Engineering Program (WIE) organized by the Office of Student Development. This program coordinates several on-site experiences during the summer for middle and high school girls interested in engineering as well as advising the women in engineering student organizations and the Rutgers University Women in Engineering Leadership League (RU WELL). The School of Engineering also provides a first-year experience by requiring all students to take an Engineering Orientation course and by working with Rutgers Univeristy Office of Residence Life to organize a residence hall for first-year engineering students.

Although women at Rutgers have access to the support of both Douglass Residential College and the School of Engineering, women were not persisting through the engineering curriculum. In order to reverse this trend at Rutgers, the School of Engineering and Douglass Residential College partnered to coordinate the Douglass Engineering Living-Learning Community (DELLC). This high-impact program aims to provide first-year women enrolled in the School of Engineering an intentional learning environment to promote their success in the field of engineering

During its inagural year, twenty first-year women in engineering participated in the DELLC. These women not only lived on a floor together in a residence hall dedicated to students studying engineering, they also had access to peer support in-residence through the Douglass PAL (Peer Academic Leader) program, professional development workshops facilitated by professional staff and a graduate mentor, and academic support through study groups and tutoring. A female graduate student also dedicated time to mentor and advise the women through their transition. Additionally, all of the women participating in this community enrolled in two required courses: the women's leadership course offered by Douglass Residential College in their fall semester and an exclusive section of the *Engineering Exploration* course offered by the School of Engineering for only the women in this community during the spring semester. Through the work of the graduate mentor and their participation in the courses, students interacted with engineering faculty and professionals to empower them to become fully integrated into the greater engineering community.

Graduate Mentor

Although the women in this program already had access to an upperclass undergraduate mentor in the residence hall (the Douglass PAL), the Douglass Project has experienced great success with providing undergraduate women access to experienced graduate students who can serve as mentors. These graduate mentors, who are more closely related to the women in the program, yet also more experienced than an undergraduate, provide an additional layer of support for undergraduate women in STEM.

The role of the Graduate Mentor for the DELLC is to advise the women, plan programs to help develop their skills and interpersonal relationships, and assist in teaching the *Engineering Exploration* course offered in the spring semester. The current graduate mentor, a second-year female student in engineering, was selected to relate to the undergraduate struggles of balancing classes with extracurricular activities and being a woman in a male-dominated field. She approached this group as an older friend or sister; someone they could trust and feel comfortable to go to in their first year and for years to come. This approach worked for most of the women in the program as most of them felt comfortable enough to come to her if they had a problem or issue.

Another major role of the graduate mentor was coordinating programs and workshops for the students that would help bond them as a group and give them assistance in areas that would help them as they integrated into the engineering community. The program that exemplifies this the best was a program where they learned to write their resumes, a skill they will always need. In addition to having someone from career services present on good resume techniques, the program included three women in their sophomore, junior, and senior years who discussed their experiences with internships, co-ops, and research. This insight gave the women a student perspective on what they needed to do and what they might expect to get from those opportunities.

Overall, the women really enjoyed their interactions with the graduate mentor and found her to be a beneficial component of the community. They sought her out for advice and found her programs useful as they got to know each other and developed academically and professionally.

Douglass Residential College Leadership Course

The *Knowledge and Power: Issues in Women's Leadership* Course is an integral part of the leadership curriculum at Douglass Residential College. The course anchors the experience of all first-year women regardless of major or school affiliation. This course analyzes the connections between the production of knowledge and women's leadership. It introduces students to theories of gender, knowledge, and agency by looking at how gender is involved in the construction of knowledge in different fields, and at factors that encourage women to achieve agency and leadership. Examining young women's leadership and utilizing peer mentors, the course engages students to become active producers of knowledge and to think critically about their own goals in education. In addition to a common set of readings, students in all sections of the course come together several times a semester to listen to lectures given by prominent women leaders.

Beginning with Adrienne Rich's *Taking Women Students Seriously*, students must consider the impact of being in an all female classroom at a coeducational institution. For many in the classroom, it is the first time they are being asked to examine the impact of gender on their decision to go to college and the academic goals they have set for themselves. To facilitate better class discussion, course sections are kept small, with the opportunity to continue learning and engagement with course themes

during outside-of-class events at neighboring centers and institutes. Peer mentors, assigned to each section, are actively engaged with helping students to get involved with Douglass' clubs and leadership opportunities. These mentors are not only women that have excelled academically in *Issues in Women's Leadership* but have chosen to enroll in a subsequent seminar that challenges them to model a more accessible and practical version of leadership to their first-year peers.

Of particular importance to the first year experience of engineers are readings that generate debate around the underrepresentation of women in science. Students are encouraged to challenge prominent gendered models of leadership development that assume that one lone charismatic leader can undo the gender bias that is inherent within educational and cultural institutions. Some women in STEM programs, for example, assume that having more female faculty will ultimately create more equal practices and treatment for women in the sciences. Feminist leadership, as illuminated in the course, can transform STEM departments at universities or colleges by empowering young women to become change agents. Programs for women in STEM need to (1) challenge visible, hidden and invisible power wherever it operates, and especially when it promotes a bias against women in STEM; and (2) construct alternative models of power that amplify the visible form to the maximum extent possible, and gradually eliminate invisible power. In other words, women in engineering are inspired to utilize feminist leadership and engage their communities to make the practice of power visible, democratic, legitimate and accountable, at all levels, and in both private and public realms [8].

ENGINEERING EXPLORATION COURSE

Engineering students at Rutgers do not declare the specific engineering discipline in which they will major until the end of their first year. During the first year, they take courses common to all of the engineering majors, including a course introducing them to the different engineering majors available to them. For most students, this course takes the form of a 1-credit hour lecture series that meets once per week for 80 minutes, during which guest speakers introduce the eight engineering majors (bioenvironmental, biomedical, chemical, civil, electrical, industrial, materials, and mechanical) and one certificate program (packaging) offered at Rutgers. The School of Engineering and Douglass Residential College decided to provide a very different, hands-on, project-based course for the community that met twice per week for 80 minutes with additional out-of-class assignments (3-credit hours), a format that is becoming increasingly popular in the first-year engineering curriculum elsewhere and that has been piloted for a small fraction of the first-year students at Rutgers since 2009 [9]. A new section of this pilot course, *Engineering Exploration*, was development specifically for the LLC, using the same project and assignment structure as the original course but tailoring the course delivery to the LLC. A faculty member and the graduate mentor served as co-instructors.

The basic course content consisted of four design projects covering five engineering disciplines: civil, electrical, biomedical, mechanical, and industrial. The students also received an in-depth tour of the chemical engineering laboratories. Incorporation of all of the disciplines into the projects is in development but not yet completed. Students worked in teams of four throughout the semester. For each project the students were provided with a brief description of the goals, key concepts, and some basic background material. They were allowed to use other resources, including the internet, and to ask as many questions as they wished as they worked on the project. Each project spanned several class periods. A variety of methods were assigned for reporting their results, including group, individual, written, oral, and poster presentations to introduce students to the different modes of technical communication.

Interspersed among the project work were short (20-30 minute) presentations by guest speakers. These fell into two categories: Department Presentations (DP; also a feature of the original course), and Perspectives on Engineering (PoE; new for the LLC course). The DP were shortened versions of the talks given in the 1-credit course. Because not all majors were represented in the projects, special care was taken to ensure that all were represented in the DP.

The Perspectives on Engineering were designed to personalize the engineering experience and expand the students' networks, by connecting them to friendly, supportive individuals in the engineering community. In addition to faculty, presenters included one graduate student and one engineer working in government. PoE presenters, all women, were asked only to share a bit about themselves and their experiences with engineering, and to entertain questions from the students. As a result, the presentation format varied widely; however, student engagement was high regardless of format. The initial PoE presentations were so well received that the syllabus was fine-tuned to accommodate more presentations than originally planned. The PoE appeared to connect with questions on the students' minds and provide an opportunity to ask them that they wouldn't have otherwise had. The students' questions exhibited an unusual awareness of school, career and personal issues, and of being a woman in engineering. This particular insight partly reflects the type of student attracted to the LLC but also the perspective afforded by the Knowledge and Power course that they took in the fall semester.

ASSESSMENT RESULTS

To assess the effectiveness of this program, the students in the community were asked to complete the Longitudinal Assessment of Engineering Self-Efficacy (LAESE) developed by The Pennsylvania State University and University of Missouri [10]. This instrument measures several outcomes including engineering career expectations, engineering self-efficacy, feeling of inclusion, coping self-efficacy, and math outcome expectations by asking students to examine their level of confidence and agreement. The students participating in the living-learning community were given a "pre-test" at the beginning of the year during the evening activities of their first night on campus, and a "post-test" in April, during the last lecture of their *Engineering*

Exploration course. Although all twenty students completed the pre-test, only nineteen completed the post-test.

To assess self-efficacy, confidence, and outcome expectations, the LAESE uses Likert scales with "0" representing no confidence or agreement and "4" or "6," depending on the question, representing the highest level of confidence or agreement. In order to evaluate whether or not the differences between their scores from the pre-test to the post-test are significant, a *t* test for related samples was run on the results from the nineteen women who completed both. When comparing the post-test scores to the pre-test scores (Table 2), interesting outcomes in areas such as the majors they declared and their feelings about their decision, working as an engineer post graduation, their inclusion in the engineering community, and their confidence in succeeding in the engineering curriculum were found.

First, the number of women declaring majors (Table 1) in aerospace, chemical, civil, industrial, and materials engineering increased, while the number of women pusuing a degree in biomedical/bioengineering decreased by thirteen percent. Further, all of the women had decided on a major by the end of the year.

TABLE I
ENGINEERING MAJOR DECISIONS

Major	Pre-test Number	Post-test Number	Difference
Aerospace	1	2	1
Biochemical	1	0	-1
Bioengineering/Biomedical	9	6	-3
Chemical	3	4	1
Civil	0	1	1
Computer Engineering	1	0	-1
Environmental	1	0	-1
Industrial	0	2	2
Materials	1	3	2
Mechanical	1	1	0
Undecided	2	0	-2

In addition to all of the women deciding on a major by the end of their first year, their confidence that they would gradaute with their current engineering major also increased significantly from the beginning to the end of the school year. All of the students indicated on the post-test that they were confident they would be enrolled in the School of Engineering with an engineering degree in the next academic year with 18 confident that they will graduate with their current engineering major and 19 confident they will complete any engineering degree. At the time of the post-test, only 4 had indicated exploring other possible majors.

When asked to consider their engineering career expectations, their overall level of confidence in succeeding in an engineering career increased from the pre-test to the post-test. They indicated a higher level of agreement to being trated fairly on the job on the post-test as well as an increased feeling of inclusion on the job if they enter engineering. However, a significant decrease was observed in their confidence that doing well in math will enhance their career opportunities and that taking math courses will help them keep their career options open.

Since women do not persist in engineering due to the feeling of exclusion, this program focused on integrating the students into the broader engineering community in hopes that they would see themselves as members. When asked about their feelings towards the other students in their classes, the level that the women agreed they could relate to their peers increased as well as their level of agreement that they have common interests. Additionally, a significant increase was observed in the level of their agreement that the other students in their classes share their personal interests.

Finally, the students also considered their engineering self-efficacy by rating their confidence in succeeding in the engineering curriculum, including the required math, physics, and chemistry courses. Surprisingly, although the students indicated confidence in completing the engineering curriculum and related courses, graduating with a degree in their chosen major, and succeeding in an engineering career, their confidence in succeeding in the engineering curriculum and the required math and science courses decreased. Yet, dispite their decrease in confidence in succeeding in the engineering curriculum, the most significant increase observed between the pre-test and post-test occured when asked about their ability to cope with doing poorly on an a test in one of their engineering courses. Although they do not believe that they will succeed in this courses, they do feel as though they can complete the coursework and handle not achieving they grades they hope to earn.

A group of first-year engineering women who did not participate in the community also completed the survey at the end of the year in order to establish a control group. Since only eight students particiapted, the Mann-Whitney *U* Test was used to observe any significant difference between the scores of the women in the community and those who did not participate at the end of their first year. Overall, there was not a significant difference between most of the scores except for their feelings towards extracurricular activites and coping with doing poorly on exams.

CONCLUSION

Even though this living-learning community has only existed for one year, it has already affected the women who participated in its programming. Despite the decrease in the students' confidence in succeeding in the engineering curriculum and related courses, participation in the Douglass Engineering Living-Learning Community did positively influence their perceptions of success in engineering and, importantly, their ability to cope with failure. Students in the DELLC also demonstrated increased confidence in completing their engineering degree after participating in the DELLC as well as stronger feelings of inclusion and coping than their non-community peers.

Although room for improvement in the engineering course and the graduate mentoring exists, student feedback has been very positive. Coincidentally, so has the feedback from faculty participants, both PoE and DP presenters, who noted and enjoyed greater engagement with the class. Further, since the programs implemented by the graduate mentor were not well attended, (the best turn out only had a

TABLE 2
LONGITUDINAL ASSESSMENT OF ENGINEERING SELF-EFFICACY RESULTS FOR WOMEN IN THE DELLC

Question/Statement	Pre-test Mean	Post-test Mean	Difference
Decision about major			
At the present time, how satisfied are you with your decision about your specific engineering major?	2.75	3.00	0.25
At the present time, how confident are you that you will keep your chosen engineering major through college?	2.90	3.21	0.31**
At the present time, how confident are you that you will be enrolled in any major in the college or school of engineering in the next academic year?	3.15	3.68	0.53**
At the present time, how confident are you that you will graduate with your current engineering major?	2.80	3.21	0.41**
At the present time, how confident are you that you will complete any engineering degree (any engineering major)?	3.15	3.26	0.11
At the present time, how confident are you that you will complete any degree (any major) at this institution?	3.70	3.79	0.09
Engineering career success expectations			
Someone like me can succeed in an engineering career	4.35	4.68	0.33
A degree in engineering will allow me to obtain a well paying job	5.75	5.79	0.04
I will be treated fairly on the job. That is, I expect to be given the same opportunities for pay raises and promotions as my fellow workers if I enter engineering	4.60	4.95	0.35
A degree in engineering will give me the kind of lifestyle I want	4.75	5.21	0.46
I will feel "part of the group" on my job if I enter engineering	3.45	3.53	0.08
A degree in engineering will allow me to get a job where I can use my talents and creativity	5.40	5.11	-0.29
A degree in engineering will allow me to obtain a job that I like	5.25	5.26	0.01
Taking math courses will help me to keep my career options open	5.35	4.74	-0.61**
Engineering Self-Efficacy			
I can succeed in an engineering curriculum	4.70	4.58	-0.12
I can succeed in an engineering curriculum while not having to give up participation in my outside interests (e.g. extracurricular activities, family, sports)	3.75	4.05	0.30
I will succeed (earn an A or B) in my physics courses	4.65	3.68	-0.97**
I will succeed (earn an A or B) in my math courses	4.80	3.89	-0.91**
I will succeed (earn an A or B) in my engineering courses	5.00	4.53	-0.47
I can complete the math requirements for most engineering majors	5.20	5.53	0.33*
I can do well in an engineering major during the current academic year	4.95	4.47	-0.48*
I can complete any engineering degree at this institution	4.10	4.74	0.64*
I can complete the physics requirements for most engineering majors	4.85	5.05	0.20
I can persist in engineering during the current academic year	4.95	5.26	0.31
I can complete the chemistry requirements for most engineering majors	4.90	4.63	-0.27
Feeling of inclusion			
I can relate to the people around me in my classes	4.35	4.53	0.18
I have a lot in common with the other students in my classes	3.85	4.47	0.62
The other students in my classes share my personal interests	3.25	3.95	0.7**
I can relate to the people around me in my extracurricular activities	4.05	4.53	0.48
Coping self-efficacy			
I can cope with doing poorly (or not as good as I had hoped) on a test in one of my engineering classes.	3.25	4.32	1.07**
I can make friends with people from different backgrounds and/or values	5.60	5.68	0.08
I can cope with friends' disapproval of my chosen major	5.30	4.89	-0.41
I can cope with being the only person of my race/ethnicity in a class	5.35	5.32	-0.03
I can approach a faculty or staff member to get assistance with academic problems	5.10	5.00	-0.10
I can adjust to a new campus environment	4.55	5.21	0.66**

* $p < .10$ ** $p < .05$

50% attendance rate and the worst had 20% attendance), next year a mentoring program will incorporate the women from this year to be peer mentors and participate in some of the programs with the current first-year students. Hopefully their influence will encourage more of the first-year women to attend the programs. This additional mentoring program will also encourage the current second-year students to stay involved while introducing the first-year women to a group of peers who have just finished what they are about to experience. Lastly, more work needs to be done to answer why their confidence in succeeding in the curriculum decreased although their perceptions of success in an engineering career and coping skills increased in order to develop interventions to address this issue.

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TABLE 3
LONGITUDINAL ASSESSMENT OF ENGINEERING SELF-EFFICACY RESULTS FOR WOMEN IN THE DELLC AND THOSE NOT IN THE DELLC

Question/Statement	DELLC	Non-DELLC	Difference
Decision about major			
At the present time, how satisfied are you with your decision about your specific engineering major?	3.00	3.00	0.00
At the present time, how confident are you that you will keep your chosen engineering major through college?	3.21	3.63	-0.41
At the present time, how confident are you that you will be enrolled in any major in the college or school of engineering in the next academic year?	3.68	4.00	-0.32
At the present time, how confident are you that you will graduate with your current engineering major?	3.21	3.75	-0.54**
At the present time, how confident are you that you will complete any engineering degree (any engineering major)?	3.26	3.38	-0.11
At the present time, how confident are you that you will complete any degree (any major) at this institution?	3.79	3.88	-0.09
Engineering career success expectations			
Someone like me can succeed in an engineering career	4.68	5.25	-0.57*
A degree in engineering will allow me to obtain a well paying job	5.79	5.63	0.16
I will be treated fairly on the job. That is, I expect to be given the same opportunities for pay raises and promotions as my fellow workers if I enter engineering	4.95	4.88	0.07
A degree in engineering will give me the kind of lifestyle I want	5.21	5.13	0.09
I will feel "part of the group" on my job if I enter engineering	3.53	3.13	0.40
A degree in engineering will allow me to get a job where I can use my talents and creativity	5.11	5.00	0.11
A degree in engineering will allow me to obtain a job that I like	5.26	5.38	-0.11
Taking math courses will help me to keep my career options open	4.74	4.50	0.24
Engineering Self-Efficacy			
I can succeed in an engineering curriculum	4.58	5.13	-0.55
I can succeed in an engineering curriculum while not having to give up participation in my outside interests (e.g. extracurricular activities, family, sports)	4.05	3.00	1.05**
I will succeed (earn an A or B) in my physics courses	3.68	5.38	-1.69**
I will succeed (earn an A or B) in my math courses	3.89	4.50	-0.61
I will succeed (earn an A or B) in my engineering courses	4.53	4.38	0.15
I can complete the math requirements for most engineering majors	5.53	5.63	-0.10
I can do well in an engineering major during the current academic year	4.47	5.00	-0.53
I can complete any engineering degree at this institution	4.74	4.63	0.11
I can complete the physics requirements for most engineering majors	5.05	5.50	-0.45
I can persist in engineering during the current academic year	5.26	5.50	-0.24
I can complete the chemistry requirements for most engineering majors	4.63	4.75	-0.12
Feeling of inclusion			
I can relate to the people around me in my classes	4.53	4.38	0.15
I have a lot in common with the other students in my classes	4.47	4.50	-0.03
The other students in my classes share my personal interests	3.95	4.13	-0.18
I can relate to the people around me in my extracurricular activities	4.53	3.25	1.28*
Coping self-efficacy			
I can cope with doing poorly (or not as good as I had hoped) on a test in one of my engineering classes.	4.32	2.50	1.82**
I can make friends with people from different backgrounds and/or values	5.68	5.50	0.18
I can cope with friends' disapproval of my chosen major	4.89	4.75	0.14
I can cope with being the only person of my race/ethnicity in a class	5.32	5.25	0.07
I can approach a faculty or staff member to get assistance with academic problems	5.00	4.75	0.25
I can adjust to a new campus environment	5.21	5.13	0.09

* $p < .10$ ** $p < .05$

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