

How was your internship? Stories about the engineering internship experience from five female engineering students

Amy Huynh, University of California, Irvine

Amy Huynh is a mechanical and aerospace engineering major at the University of California, Irvine. She is interested in better understanding and supporting the experiences of female engineers in the classroom and in industry. She is involved in senior design projects for the CanSat and Design/Build/Fly competitions.

Prof. Natascha Trellinger Buswell, University of California, Irvine

Natascha Trellinger Buswell is an assistant professor of teaching in the department of mechanical and aerospace engineering at the University of California, Irvine. She earned her B.S. in aerospace engineering at Syracuse University and her Ph.D. in engineering education in the School of Engineering Education at Purdue University. She is particularly interested in teaching conceptions and methods and graduate level engineering education.

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Abstract:

This paper shares the background, motivation, and methodological approach for a study using narrative analysis. The participants will be five female undergraduate students who have had engineering internship experiences and are currently enrolled at a Large Public Southwestern R1 Institution. The research project described in this work-in-progress paper details the plans to accomplish the following research objective: to document and describe the industry experiences of female engineering undergraduate students in relation to their learning experiences back in the classroom. The narrative stories, which have not yet been constructed until the IRB is approved for data collection, are guided thematically by examining the female students' perspectives before, during, and after their internship experience. This paper serves to explore how the differing experiences of classwork and internship influence each other and how female students benefit from being exposed to both. This paper details the motivation, related literature, and methodological approach to a narrative analysis study to address the direct relationship between the academic and industry experiences of female engineering undergraduate students.

I. Introduction

As students pursue their engineering undergraduate education, they may seek industry experiences through internships to supplement their academic classwork and to gain hands-on experience. Internships allow students to learn about the industry through the eyes of an employee by working on a company's project and to have a mentor or advisor to guide them throughout the internship and to share their personal experiences, career pathway, and advice. Meanwhile, back in the classroom, engineering students typically focus on learning theoretical concepts and working on problem sets and receiving guidance from the professor and/or teaching assistants. Both academic and industry experiences help to shape students as they become engineers.

There has been some research on how male and female engineers and engineering students differ in their experiences. Since women remain a largely untapped resource in meeting the demand for a skilled scientific workforce, it is important to understand why they remain underrepresented in both engineering programs and industry. While considerable attention has been paid in the literature to the issue of attracting and retaining more females in engineering, enrollment numbers have remained virtually stagnant for over 20 years.¹ For the U.S. to remain competitive in the global economy, it is essential to retain more women in engineering.

As our nation's potential scientific talent pool expands to include more persons from diverse backgrounds, particularly females, so does our need to understand their educational experiences, industry experiences, as well as the barriers and supports that relate to their path through academia and industry. In this paper, I will present what research been conducted so far in a literature review, present the methodology of how I will collect and analyze data, as well as summarize the expected results and implications.

While understanding the broad trends of women in engineering, this study seeks to dig deeper into the stories of the research participants. Narrative analysis was chosen to create a more clear understanding of the role that engineering-related work experiences play in female undergraduates' engineering experiences. Specifically, the paper examines the following research question:

How do female engineering students describe their internship and classwork experiences and how these experiences impact each other?

This work-in-progress paper describes studies and findings from related literature and explains the methodological approach for a proposed study. The following sections provide background and justification for studying the relationship of academic and industry experiences in the undergraduate years of female engineering students.

II. Literature Review

Undergraduate engineering experiences may involve both academic experiences in the classroom as well as industry experiences through internships. These industry experiences are generally off-campus and take place during the summer, although students may have internships concurrently during the school year or in place of an academic term. Internships provide students with the opportunity to learn about engineering as a career through observation and participation at a job site.² Students typically pursue internships after completing their sophomore year, but some students may start them earlier.

Although there is also growing literature studying how internship experiences affect female undergraduate engineering students' career pathways, there is a less literature describing how these experiences affect students' learning experience in the classroom after the internship experience. Current literature on the effect of internships on women engineers do not focus enough on the relationship between the experiences in academia and industry.

In addition to providing current examples of women in engineering, this paper seeks to inspire future generation of girls in STEM. Despite females being awarded 19.9% of all Bachelor's degrees from an engineering program in 2015, women only represent 13% of the engineering workplace.³ Women's representation in engineering declines further at the graduate level and in the workplace. This discrepancy highlights problems that specifically affect women such as lack of professional mentorship and role-models and lower confidence for female engineers which may in turn decreases the retention of women in engineering.^{4,5}

Although the number of women in engineering is increasing, men continue to outnumber women. The female experience in engineering in colleges and universities is often shaped by underrepresentation in the field both in the female population of students and faculty members.³ Many people may associate STEM fields with "male" and humanities fields as "female."⁴ This implicit bias affects the attitudes of individuals as well as women's likelihood of cultivating their own interest in math and science. Alongside this bias, people may also view women in "masculine" positions such as scientists or engineers in a negative light.⁶ A competent woman in a "masculine" job may be considered less likeable, and a woman might feel that she needs to adjust her behavior in order to belong in the workplace. Women in STEM, especially as they enter the workplace, face the challenge of finding the balance between likability and competence in order to be successful.⁴

Recent research in girls' mathematical achievement demonstrate the "importance of culture and learning environments in the cultivation of abilities and interests."⁷ In order to diversify the STEM fields, it is crucial to be aware of the stereotypes and biases that exist and to pay careful attention to the environments in classrooms and workplaces.⁶ Providing insight into the internship experiences of female engineering students will encourage representation of female stories and understanding of the workplace environment that these students will enter. The industry environment that these students experience may be very different from what they have experienced in academia; emphasizing these different environments allows females to be prepared and for both the educational and workplace environments to make adjustments to be more welcoming and supportive of women.

The female perspective is especially important to study because it allows for better understanding of how female students can benefit and learn from internships, and point to ways to help diversify the field of engineering. By diversifying the engineering environment, more unique perspectives can be represented and provide new innovations and ideas. An understanding of what students value within work experiences can help industry recruitment efforts towards female engineering students. It can also help to inform instructors of course activities that may be implemented into the classroom so that academic and industry experiences

can be made sense of together. This study looks to inform recruitment strategies into engineering in academia and industry.

Lichtenstein and colleagues found that "internships that provide candidates with work experiences in industry can be important for building professional networks that increase affiliation with engineering and thereby encourage persistence."⁸ For female students in male-dominated engineering classes, it can be difficult to find female role models or faculty members to encourage them to continue pursuing the engineering field. Internships provide access to hands-on engineering experience and real engineers who can inspire these female students to keep pursuing their engineering studies. Having professional connections allows these students to believe that their goal of becoming an engineer is attainable and that their persistence will help them achieve their goals.

Given that the learning experiences of female undergraduate engineering students after internship experiences are largely unknown, and therefore the relationships between academia and industry are unknown, this topic is worthy of study. This paper will likely help female undergraduate students to understand the benefits of pursuing an internship and to learn whether the experience aligns with their personal interests. Industry companies who have internship programs may also find this paper useful for understanding how to shape their programs in effective ways for students. Finally, instructors and educational administrators might utilize the findings and resulting narratives to inform their classroom environment and understanding of the female engineering student experience.

III. Methods

Narrative analysis was selected as a means of examining five to six female engineering undergraduate students in a multiple case study.^{9,10} Narrative stories are sought to provide a rich description of the experiences of female engineering undergraduate students and to provide stories that humanize these students and their personal experiences. The qualitative interview is useful in developing descriptions of diverse experiences,² and especially successful in elucidating the perspectives of STEM students from underrepresented groups.

Each participant will undergo one interview focusing on three main topics: 1) perspective on classwork and perceptions on becoming an engineer before the internship, 2) perspective on classwork and perceptions on becoming an engineer during the internship, and 3) current perspective on the relationship of experiences in academia and industry.

The interviews will be conducted over video chat and will be audio recorded and later transcribed. Every research participant's interview will represent an individual case.

Semi-structured interviews will be conducted with participants to gain an understanding of student experiences through their own words, which allows both the researchers and participants to engage in conversations with purpose.

The interviews will be conducted using an ethnographic interview approach in which the researcher views the interviewee as the informant. I will inform the participant that I see them as the expert of their story and will encourage them to lead the conversation. Each participant will be informed that she is viewed as an expert of her story and will be encouraged to lead the conversation. Since narrative analysis relies on critical events of the participant's story, the participant will have free reign to guide the conversation with their thoughts and experiences in response to my general questions. The participants will be encouraged to do most of the talking, though the interviewer will provide guidance based on the research questions of the study and ask follow up questions when necessary. However, there will be as few interruptions as possible in order for the participant to speak her mind freely and to provide direct quotes that may be used in the narratives as findings for each individual case.

I will identify five to six participants for this study through my university's engineering department. The goal of using narrative analysis in this study is for readers to understand that there exists variation in each experience and to be able to connect with the participants and their narratives. The following eligibility criteria will be used to identify research participants:

- Identify as female
- Have had at least one previous engineering internship experience
- Be enrolled in an engineering major
- Be currently enrolled in courses

Specifically, the study will employ the following interview protocol to guide the interviewee:

Interview Protocol

1. Walk me through your perspective on classwork and perceptions on becoming an engineer before your internship
 - a. What made you seek an engineering internship?
 - b. What were you expecting from your internship?
 - c. What was your attitude towards your schoolwork?
2. Walk me through your perspective on classwork and perceptions on becoming an engineer during your internship
 - a. How much of your classwork could you apply to your work? (Any specific classes?)
 - b. Were there any times where you became aware of your gender and its effect on your experience in the workplace?

- c. Were you satisfied with the tasks you were given?
 - d. Were you satisfied with your mentors during your internship?
 - e. Was there anything you would have changed about your experience?
3. How do you think classwork and industry experience relate?
- a. How well did your expectations for the internship match with the reality of your experience?
 - b. What skills did you acquire from the internship that you use in class?
 - c. Compared to previous academic terms, was the term after your internship experience different? If so, how?
 - d. Has your attitude towards your schoolwork changed?
 - e. Are there any other aspects of your identity (such as ethnicity, first-generation status, interests) that impacted your experiences in your internships and/or school work?

IV. Implications and Expected Results

The results from this study are expected to contribute to engineering education literature, specifically literature addressing the relationship between academia and industry, in three ways. First, industry internship programs might consider to provide interns with more diverse mentors as part of their internship experience. Successful engineering recruitment programs should emphasize the important roles that role models play in the selection and persistence of female students. Second, by exploring the narratives of these current students, future students will be made aware of the options to connect their experiences in academia and industry. The narratives may serve as an inanimate “more competent other”¹² for future female engineering undergraduate students, where the narratives provided by current students with varying academic and industry experiences can provide insight to students pursuing internships. Two hypothetical scenarios about a student’s interaction with a narrative demonstrates this idea in Figure 1. Third, this research may provide an understanding of how to improve current teaching methodologies in order for engineering students to best connect theoretical classwork with real life applications and the workplace. This can also help colleges on shaping their career path programs and provide more guidance to students who seek industry experiences as undergraduates.

<p>Emily, a female engineering undergraduate student: Emily is starting to look for internship opportunities for the summer and has realized she wants to have an industry experience</p>	<p>Talia, a female engineering undergraduate student: Talia is a freshman interested in pursuing a career as an engineer. Although her interests in engineering stem from her strength in science and mathematics courses, she does</p>
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<p>related to the classes she will take in the future. She reads a narrative that explains how a student like her was able to intern and to apply the hands-on knowledge she learned to her classes the following quarter. Emily feels that she has found a role model and guidance towards a path she is interested in pursuing. Reading about the internship experience gave her new motivation to continue pursuing her more arduous academic classes.</p>	<p>not know anyone in the engineering profession. She reads a narrative that explains how a student experiences the industry during an internship. She realizes that working as an engineer is different than what she had expected. She no longer wants to pursue a career in engineering and is able to decide on a new pathway that more closely aligns with her interests. Having more representation on the engineering workplace has helped her learn what to expect as an engineer.</p>
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Figure 1: hypothetical interaction with narrative

This study may be of interest to female undergraduate students by providing insight on how they may or may not benefit from an internship experience. Female students may feel inspired and empowered to apply to an internship that they may have been previously discouraged from doing before. Industry companies who have internship programs may also find this paper useful to understand how to shape their programs in effective ways for students. Schools may also benefit from this paper by incorporating more applications to typically theoretical classwork. It will also likely be useful to help high school and undergraduate students become more aware of the realities of engineering work, helping them determine if and how engineering is the right career choice.

V. Conclusion

The paper presented the methodology for analyzing the narratives of five to six female engineering undergraduate students. This work-in-progress paper adds to the engineering education literature relating academic and industry experiences and serves to explore how the differing experiences of classwork and internship influence each other and how female students benefit from being exposed to both. This paper will likely interest female undergraduate students who are considering internship experiences and will provide them with a better understanding of what they can gain from them. Industry companies who have internship programs may also find this paper useful to understand how to shape their programs in effective ways for students. Furthermore, academic institutions may benefit from this paper by incorporating more applications to typically theoretical classwork. This research and its findings can also provide insight to current female engineering students and their professors. Female students may feel inspired and empowered to apply to an internship. The researchers are awaiting IRB approval and will then begin data collection and analysis in hopes of providing more tools for and accessibility to the female internship experience to help diversify the engineering profession.

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