



Seeing the Big Picture: The Role that Undergraduate Work Experiences Can Play in the Persistence of Female Engineering Undergraduates

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Abstract

Internships and co-ops provide a variety of benefits to students who participate in them. This study describes the benefits that are accrued by female undergraduate engineering students who participate in internships and co-ops. The paper describes how internships and co-ops can enhance students' learning, connect students with professionals in the industry and provide a *taste of the future*, all of which contribute to female students' professional role and career-fit confidence. All of these benefits ultimately influence female students' decisions to persist to graduation and pursue a career in engineering. The paper also describes how internship and co-op experiences affected the education timelines of females who switched out of engineering into a different major.

Introduction

There is strong evidence of student flexibility and vacillation around career options post-graduation from college. Specifically, a single interaction or experience (such as a co-op) can sometimes mean the difference between taking a job after graduation in engineering or another field.¹ Further, research suggests that cooperative education and internships result in increased social and cultural capital of those who participate, which can contribute to their ability to secure employment after graduation.² Student perceptions of the engineering field, which can be shaped by undergraduate work experiences, can also impact persistence in engineering programs.³⁻⁷

While there is a growing literature examining the relationship between undergraduate work experiences (internships & co-ops) and academic and post-graduation outcomes such as starting salary and likelihood of job offers⁸⁻¹⁰, there is less literature describing how a student's experience in an engineering-related internship or co-op affects their undergraduate engineering experiences, their perceptions of the field, and ultimately, their likelihood of staying in the major and graduating with an engineering degree. The literature on the effect of cooperative programs or internships on women generally focuses on the specific outcomes of these types of undergraduate work experiences, such as job offers and satisfaction with first job.^{11,12}

This research digs deeper to create an understanding of the role of engineering-related work experiences in female undergraduates' engineering experience. Specifically, the paper examines the following research questions:

1. What do these internship and co-operative education experiences mean to female engineering students?
2. How, if at all, do experiences of internships and co-operative education differ between women who stayed in engineering and women who switched out of engineering majors?

The paper begins with a review of existing literature focused on engineering-related undergraduate work experiences, such as internships and co-ops, and their effects, followed by a description of the research methods, study findings and concluding thoughts.

Literature Review

Internships and Co-ops Defined

Undergraduate engineering work experiences can take a variety of forms. In this paper, we look specifically at engineering-related work experiences in the form of internships and co-ops. Much of the research focused on internships and co-ops either lacks definitions of these two types of work experiences or provides very different definitions. Therefore, the definitions utilized in this paper come from information provided on participating school websites.

Internships are generally an off-campus learning experience that may be related to a student's major and that provides the student with the opportunity to learn about the engineering profession through observation and participation at a job site. Most engineering internships take place during the summer, and are full-time, paid work. Students are typically encouraged to pursue internships after their sophomore year, but some students start them as early as the summer after freshman year.

Co-ops, or cooperative learning experiences, generally alternate terms of study with terms of full-time paid work, combining classroom theory with career-related work experience. Some schools offer academic credit for co-op participation, while others do not, and some programs offer increased responsibility with each return or rotation. Students typically start to pursue co-op experiences toward the end of their sophomore year, and many schools do not limit the number of terms in which students can participate. Unlike internships, however, students typically participate in co-ops during school terms, and do not take classes at the same time. Thus, these experiences can extend their degree programs by up to a year or more.

Improved Understanding of the Engineering Field

Research indicates that participation in work experiences, such as internships and co-ops, can provide a range of benefits to engineering undergraduate students. Through these work experiences, students can develop a better understanding of the field of engineering.¹³⁻¹⁵ For example, engineering students often view internships as more representative of what it means to be an engineer than their classroom experiences.^{13,14} They also learn about various technologies and processes used in the workplace, the range of activities that an engineer may undertake, and how different aspects of engineering connect and interact.¹⁵

Influences on Student Confidence and Career Decisions

Beyond developing a better understanding of the engineering field, research also demonstrates that students' confidence and motivation can be influenced through their engineering-related work experiences.¹⁵ Further, students' perception of the profession can influence their decisions to persist in engineering.^{1,5} *Professional role confidence* refers to students' confidence in their ability to fulfill expected roles and competencies—a key factor in becoming a successful professional.⁵ Professional identity development can be influenced by interactive, intellectual, and concrete experiences during professional training, and often relies on verification from relevant others.⁵ Through interactions with faculty, mentors, and peers, both in and out of the

classroom, students begin to engage in professional behavior as they start to master technical knowledge and practical competencies and learn to develop a confident demeanor.⁵ While coursework and related activities alone seem unlikely to help students adequately develop professional role confidence, the addition of internship or co-op experiences can integrate explicit learning objectives related to career advancement in engineering with a broad range of required skills for success in the field.⁵

Career-fit confidence, students' confidence that a particular profession is suitable for them and will provide interesting and worthwhile employment, also impacts decisions to persist in engineering.⁵ In other words, it's less about students' assessment of their abilities, and more about their alignment with the culture and ethos of the profession.⁵ For example, women's interest in *family-flexible* professions can negatively affect their intentions to persist in male-dominated fields, such as engineering.⁵ However, women who have had internships or other forms of engineering-related employment tend to be less likely to perceive conflicts between career and family, which can influence their decisions to persist in engineering.¹⁶

Professional Development and Socialization

Students' socialization or learning about the professional culture within engineering organizations can contribute to their professional development.¹⁷ Just as important is learning how to function within an organization.¹⁵ Researchers argue that internships and co-ops provide students with organizational and cultural experiences that facilitate mastery of communication skills, professional ethics, and collaboration.¹⁷⁻¹⁹ Further, these work experiences can also contribute to students developing relationships with mentors and networks that can contribute to their success in the profession^{15,17}; and the accumulation of these types of experiences can develop students' social capital such that they may have thus creating access to additional job opportunities.^{2,17}

Increases in GPA and Starting Salaries

Quite a bit of research has focused on the extent to which undergraduate work experiences impact things like Grade Point Average (GPA) and starting salaries in post-graduation employment. A number of studies found that co-op students had higher GPAs than non-co-op students.^{12,20} Another set of studies found that students who participated in co-ops received higher starting salaries than those who did not.^{10-12,21-27} However, various limitations, such as a lack of statistical significance or a lack of specific relevant data, puts into question the validity of these studies.⁹ One study, however, confirmed what the others were trying to establish—that students with undergraduate work experiences achieved higher GPAs upon graduation and received higher starting salaries in post-graduation employment—without significant limitations.⁹ In addition, this particular study also demonstrated that students with undergraduate work experiences also were more likely to receive a full-time job offer prior to graduation, and that the benefits increased with the number of experiences.⁹ Further, work experiences were found to benefit female students no differently than male students with regard to GPA and starting salaries.^{9,28}

Some Negative Aspects of Internships and Co-ops

While internships and co-ops can provide a variety of benefits, particularly with regard to intellectual and professional development, they can vary in valence, and like all forms of apprenticeship, they are subject to certain limitations.²⁹ For example, students may be relegated to completing inessential and inauthentic tasks, which can limit the extent to which they are able to learn anything valuable from the experience.²⁹ Further, they may have few or no opportunities to engage in a substantial range of engineering problems or take risks inherent to real problem solving.²⁹

In addition, a single internship experience can result in a limited or distorted perspective and become the basis for over-generalizations regarding working conditions, job responsibilities and career options.^{1,30-32} In fact, one study found that students' thoughts about career options were strongly swayed by a single experience, such as an internship.¹

Research Methods

This qualitative inquiry, which is part of a larger research project funded by the Alfred P. Sloan Foundation, known as the Project to Assess Climate in Engineering (PACE), focuses on making sense of the realities and experiences of undergraduate engineering students and thus incorporates an interpretive perspective.³³ Qualitative interview approaches have been useful in developing descriptions of diverse experiences³⁴, and particularly successful in elucidating the perspectives of STEM students from underrepresented groups.³⁵⁻³⁷

The research settings are 12 US universities, ranging in size from 3,817 to 50,995 students with an average enrollment of 24,221 students. Eighty-three percent are public universities, fifty percent are designated "very high research activity" under the Carnegie Classification, and seventeen percent are Minority-Serving Institutions. Students were selected to participate in the study based on a stratified random sample of currently enrolled engineering majors 18 years of age or older (*stayers*), and a purposive sample of students no longer enrolled in engineering but still at the same institution (*switchers*).

Semi-structured interviews were conducted with participants from the spring of 2008 to the spring of 2009 to gain an understanding of student experiences in their own words, allowing the researchers and participants to engage in *conversations with purpose*.³³ One-on-one interviews were conducted and audio-recorded at each participating institution by trained PACE research team members and consultants. Of the eighty-seven female students interviewed for the larger project (66 *stayers* and 21 *switchers*), this study analyzed interviews with twenty-seven female students ranging in age from 19-24, all of whom indicated experience with an internship or co-op (24 *stayers* and 3 *switchers*¹).

Data analysis, using NVivo 9 qualitative data analysis software, incorporated a combination of both open and focused coding methods.³⁸ Research questions provided a lens for the notation of

¹ Although the number of switchers is relatively small in comparison to the number of stayers, their perspectives help shed light on distinctions that may exist between stayers and switchers with regard to engineering-related work experiences.

ideas and themes, as well as for code generation.³⁸ This led to organizing and grouping data by theme and relationship to other data, moving from general to specific themes and vice versa, in order to understand the phenomenon being studied.³⁹ Throughout the process, we looked for patterns, themes, and regularities, along with contrasts, paradoxes and irregularities. Data displays such as matrices were enlisted for organizing and exploring the data.⁴⁰ Various techniques such as analytic memo writing were used during the analytic process to help interrogate, systematically explore, and make sense of the data.³⁹

Research Findings

Student participants had much to say about their internship and co-op experiences. These experiences played a key role in their undergraduate engineering programs, as well as in their decisions whether to persist. The internships and co-ops took place in different types of environments, including placements in governmental organizations and agencies, large and small businesses, as well as nonprofit organizations. Some students talked about having a single placement, while others described having multiple placements.

Those who had multiple experiences either described working in a different organization each time, or working in the same organization for all placements. Some students who worked at the same organization described benefitting from working with different people each time. Others explained how they were able to build on their previous work with each new experience or internship, providing them with increased responsibility and the ability to see how a project progressed over time. One student described working for the same company each time she interned, but being placed in different locations and departments, which allowed her to experience different fields within the same organization. Students also talked about starting to intern during high school and continuing that form of learning in college.

I really enjoyed my internships the past two summers...it probably helped that the company treated their interns really, really well. I interned there twice, and both summers...I was working in the same area, same department, same kind of tools, but with different groups. So it was really interesting and kind of cool that I got to...use things that I had learned in class. And I was like, "Okay, so these aren't totally useless; I can apply them in real life." And it's like, "I'm grown up, and I have a job, and I'm getting paid for it. So that's really cool." –Asian Female – 4th Year (P24)

The nature and quality of student experiences depended on variety of factors. These included how they were treated by employees, the type and/or amount of work they were expected to complete, whether the organization or specific department previously had interns, whether students felt like they were making a contribution to the organization, and the general work environment, such as current employee job satisfaction.

Then outside of school, in my internship, this one guy that I worked with – he saw so much potential in what I could do that he put me on a project to design something myself...And so I ended up designing these brackets that were used to put a radio inside of the bracket to mount it into a military vehicle. And they actually – like now they manufacture that product, and they use

it in the field. And they send it out, and it's one of their products, and I designed it.—White Female – 3rd Year (P25)

Female students currently enrolled in undergraduate engineering programs (*stayers*) described some specific benefits they associated with their internship and/or co-op experiences. Many of these women talked about how much they learned about the real working world of engineering. For example, they described learning about what different engineering work environments were like. They learned about the kinds of equipment used in the engineering field, along with the terminology used. They gained insight into different processes that engineers go through as part of their work, along with budgets and resources available.

I worked for the Corps of Engineers – the US Corps of Engineers for two summers. And last summer, I had a pretty good experience. I really liked it, because I feel like I get to see what I'm going to be using it, and stuff like that...So I just got to be knee-deep in all this information. I was going through RFIs; I learned all the terms and stuff, the paper work, how it works between the government and a contractor, about bids. It was just like a course on everything, you know, contact information, about letters of correspondence. Yeah, letters of correspondence, and how important it is to be organized. Just learned a whole lot from that.—American Indian Female – 2nd Year (P13)

Some also explained that they had the opportunity to learn about the stakeholders involved, or they had a chance to work directly with clients. Further, students described being involved in real-life situations and facing real-life issues and challenges, which provided them with genuine problem-solving experiences, through which they were able to develop their communication and collaboration skills.

I think [my best engineering-related experience] would definitely be my internship. Yeah, it showed me what went into construction, because that's what I want to do...And it also gives you a chance to interact with professional people. And what it's like to be in a work environment. I almost value that more than the engineering experience, because I think how you interact with other people will get you places in life. It's not always about what you know. If you have a lot in your head, and you have all this knowledge, but you can't communicate it to other people, it's hard to get anywhere. And they want us to be able to communicate. We're always doing group presentations and group projects, so you can interact with other people and learn how to work with others.—Asian Female – 2nd Year (P4)

In addition to learning much about the real working world of engineering, many female *stayers* made references to connections they were able to make between their coursework and the actual engineering work. They realized how what they had been learning in class applied to the real work of engineers. They also realized what aspects of their coursework did not generally apply to the work they were doing on the job.

I really enjoyed my internship over the summer, and I got to do a lot of hands-on stuff. Because when you're just sitting here doing calculations and stuff, you wonder is this really what you're going to be doing in ten years. Kind of hope I'm still not going to be integrating all the time in ten years. So I feel like that was definitely a really good experience, because I got to see the

different aspects. And that it's not all just going to be straight math and bookwork three years from now.—White Female – 2nd Year (P2)

Relatedly, some students talked about having the opportunity to apply what they were learning in class to real-life situations.

But I think my favorite part is – because I have these jobs – and then there's the stuff I'm learning in school. I remember in high school they're just like, "Here, learn this out of the book." And you're like, "Okay, how am I going to use that?" But whenever I got in the co-op thing, and even here, it's like, "Go to class, learn a bunch of stuff." And then you go work and you're like, "Hey, I just learned that, that's so cool. I can do that now." And so you can use it, and I just think it's awesome being able to use the stuff that I'm learning in my classes so quickly, right after I learn it.—Latina Female – 2nd Year (P22)

Not only did female *stayers* describe the learning they gained from these engineering-related work experiences, they also described a variety of networking opportunities. For example, they described making connections with students from other schools, both undergraduates and graduates, who were also interning at the same organization. In some instances, depending on the nature of the internship, they also talked about connecting with professors from other schools. Many also explained how they benefitted from networking with engineering professionals with whom they worked. In some cases, these relationships took the form of mentorships, where the engineering professionals advised students on both current work and future plans.

I worked for the Department of Transportation over the summer, and I had a great opportunity to do research for them on contact-sensitive solutions, which is pretty much taking into account all the different stake-holders. And that was great, because I pretty much got to go to a three or four-day long conference, where engineers were at, and I got to talk to people in primarily transportation engineering, which may nor may not be what I work in. But it was definitely a great opportunity to get to meet other engineers. [It was an internship.] I worked for [the state] DOT in their chemical lab, which is kind of outside of what I would do. But I talked a lot to my boss there, who was a chemical engineer, about engineering – just classes. It was a good experience to get to meet people who are actually in the work force. Because I met some project engineers, and talked to them about how their projects went, budgets, how different kinds of stake-holders can affect a problem. So I guess that was a real learning experience, because you get to see it in action. See this is what is actually involved in engineering. As opposed to just the math and science behind it.—White Female – 3rd Year (P6)

Many students expressed that their confidence increased as a result of participating in internships and co-ops. They explained how through the engineering-related work experience they realized that they were able to do the work, something they may have questioned at other times during their program.

I'm going to get back to my co-op again. I did that and I loved my job, and I'll go back in a heartbeat and just know that that's where I want to be with the other engineers and do what they're doing...I was in Renewable Energy with GE, and so I got to work with wind and gas turbines, and I'm doing another rotation I'm really excited about too...I found out that I love

what I'm doing, and I have a really big interest in energy now...[The co-op has made me more confident] -- maybe not in class work, but in industry. I feel more confident that I'll be able to perform my job once I'm out of college, not exactly more confident to pass my classes... [The co-op] was the best decision I made in college.—White Female – 3rd Year (P7)

They also described how their work experiences reaffirmed how much they had learned in their programs, and when they compared their skills and knowledge to other interns they worked with, they realized how well-prepared they were. All of these contributed to increased confidence for a number of female *stayers*.

[My confidence in my ability to do well in engineering has increased], especially last summer I did [a research internship], and it was for biomedical engineers, and it was the first time I was out. Because I know how I stack up against other [engineers at my school], but I didn't know how I fared against other people. So I was kind of nervous about that. But I did really well, and I got to go [back] in February for a conference. And like I still – once in a while my group leader, who's a first-year PhD student will send me the stuff relating to our project. He'll be like, "Figure this out for me." So I still work with them occasionally, so it was just kind of that definitely gave me such a big confidence boost to see how I fared not just among [fellow] students, but...the engineering – the whole population. —White Female – 4th Year (P27)

In addition to the aforementioned benefits, students also characterized these engineering-related work experiences as a “taste of the future.” In other words, students had the opportunity to get a feel for what the working world is like, which many described as something to look forward to.

[The best engineering related experience I've had was] definitely my internship. Last summer I went to the National Institute of Health, and I was an intern for about three months, and I actually kind of saw the big picture. I saw all the things I learned in my classes used. I got a taste of imaging, which is what I'm interested in pursuing. It was great. I used pretty much everything I've ever learned for that internship. So it was really great.—Asian Indian Female – 3rd Year (P12)

They also enjoyed being able to do project-based real work. Further, they appreciated having a break from classes, getting paid to do work, and having fun during the process. While some described their experiences as confirming their interest in a specific engineering field, others recounted how their experience helped them figure out specific interests within their field.

I've co-oped for a total of four quarters, and doing electrical engineering work – I just really like it. It's really a lot of fun...and basically they gave me real work that any of the other people would work on. I got my own projects...so they gave you real responsibilities, but then they were also really willing to help, and they told you the resources to find...I would write them programs that would actually do what they were doing by hand, and they were really impressed by that...I really helped to like innovate their process...I got a chance to use all the theory I've been learning.—White Female – 4th Year (P16)

Finally, some female *stayers* reported that they secured a job as a result of their internships or co-ops. These included post-graduation employment, as well as additional internships or co-ops.

I was lucky enough to have four internships. Between senior year of high school and freshman year I was put in a company – it wasn't technically an internship, but I worked in a lab, and I had a lot of experiences my peers didn't. And because of that job I was able to get jobs every summer, as opposed to being a freshman and looking for summer internship and saying, "Oh, I've worked at McDonald's. And I've worked at a coffee shop." I was able to say, "Oh, I've worked in a research lab." So it helped me... I've had three engineering internships, and I've already been hired.—White Female – 4th Year (P20)

Some overlap existed across *stayers* and *switchers* with regard to internship and co-op experiences. Essentially, students in both groups found that their internship or co-op experiences provided them with motivation to continue in their engineering program. Students recounted how their lack of interest in classes and coursework were overcome by their enjoyment of their work experience. This *stayer* said...

I don't really like the classes in school very much, but I did like the internship. So actually my first internship [after my freshman year] I think also [helped me decide] to stay – it was a big factor...I did two years at NASA and then one year at Owens Corning...all the classes I really didn't like. This is nothing I'm interested in, but then I got to the job and I saw that I really liked what I was doing at my job. So it kind was like, well if I get through classes, I can find a job that I really like in engineering, so I might as well stick through these torturous classes and everything and then I might really enjoy what I'm doing afterwards, so it makes it worth it.—White Female – 4th Year (P14)

Stayers in particular, expressed how their internship or co-op confirmed their interest in engineering and/or validated their coursework, which provided them with additional motivation.

After doing my internship, I realized I really like what I do. I realized I don't have to sit in a cubicle; I can do what I do, and then manage people who sit in their cubicles, or lead projects. There were more options. But I think if I never had an internship, I definitely wouldn't have made it this far...I work at Merrick Electric Power – it's the utility company, and when I was – my first year, I just basically drafted. So I got familiar with steel, and just what drawings looked like. And then I went back the next year, and I got to do like simple designs and then draft it. And then my third year, I'm doing bridge inspections, and helping people. Like I'm a normal – just an engineer like everybody else. Just each year I had more responsibility, and it never seemed overwhelming. When I'm at school, it seemed overwhelming, but once I saw the real-life situation, it's more common sense than plugging in integrals...It seemed like very simple and common sense. It wasn't like the extreme math that they put us through. —White Female – 5th Year (P15)

Students also reported realizing the different options available within their field, as well as honing in on and pursuing specific interests based on these work experiences.

[M]y first couple of years on campus I wasn't sure how much I wanted to be [an] engineer. But after I had my internship last summer, I realized that the aspects of engineering that I wasn't attracted to aren't the only aspects that are out there. And so I've just kind of narrowed down

that I don't want to be a research and development engineer for the rest of my life. But that there are other options, and potentially working in the marketing department for an engineering company, or technical sales for an engineering company is something that's more suitable for my likes and dislikes...after having an internship and seeing that it's just a matter of figuring out what does and doesn't work for me. And then kind of pursue down that road that is more my style. And also just the fact that I was always raised that once you start something, you should finish it...And so for me, that was the most rewarding single experience I've had in the past four years was to see what all of this knowledge and all of these skills that we gain...how they come into play later.—White Female – 4th Year (P17)

Once I started getting into classes that I enjoyed as well as internship experiences that showed me that this isn't your only option. You don't have to only do this; there's more to engineering, or do what you want to do. It helped me see that I actually do like this; I can do it...I guess I just really enjoy it; I've gone through a lot of internship experiences, and I've loved it, loved all of them. As well as what they say – engineers make good money. –White Female – 4th Year (P26)

Switchers

While the number of switchers relative to that of stayers is relatively small, their perspectives are nonetheless relevant and helpful for us to understand how experiences may differ for switchers versus stayers. Unlike the female *stayers*, the female *switchers* were only motivated to continue in their engineering programs for a limited time. Two of the three switchers reported staying in engineering longer than they otherwise would have as a result of their internship or co-op experiences, however. They explained that this was the case due to the fact that they enjoyed the work experiences much more than classes for a variety of reasons. For example, they found the work to be more hands-on. They also described getting positive feedback and future job opportunities as a result of their internships or co-ops.

It was just, engineering wasn't my thing I found out. It took me a while. My parents kept telling me to switch majors, because they knew I wasn't really doing well and I wasn't liking it. But, "No, this is going to be a good career, good salary." Because I liked my co-op, that was the thing. It kept me going...Maybe if class is more like the real world. When I did my co-op, I loved my co-op, I did the whole year, and then I worked part time... That's probably what kept me in the mechanical engineering program for two years, was when I was working there, because if I can get out and get my paper, my degree, and work like this, I can do this...if you learned stuff like I learned in my job in class, I think it would be better. –White Female – 5th Year (P9)

Two of the *switchers* were encouraged to stay in engineering longer than they otherwise would have as a result of their internship or co-op experiences; however, this was not the case for everyone. One *switcher* recounted how her experiences helped her decide to leave engineering.

I worked a summer job for this lady, she wasn't very intelligent at all, and it was irritating to take orders from someone who wasn't intelligent; didn't value anything you said; didn't appreciate the effort you put in. And I was like that could happen if I worked for, say, Eli Lilly. It's distinctly possible, really, anywhere, except for if I worked for myself. [What else contributed

to my wanting to leave was] I had an engineering internship over the summer. I didn't like it either. I met some nice people, and it was certainly convenient for me – it was a good experience. But I decided it wasn't for me, it's not what I want to be doing for 30 years. — Native Hawaiian/Pacific Islander Female – 3rd Year (P21)

Two of the three *switchers* in this study explained that they probably would have completed their degree in engineering if they could have had more hands-on, work-related experiences, such as an apprenticeship with learning embedded in real-life work experience. They suggested providing more work-related opportunities for students early on in their programs, such as in the first year or two.

In my junior year, I'd gotten an internship at a civil engineering company, and that was a great experience, and that's what kept me in it for so long. I was doing well in the company, and they were very proud of my work, and had offered me a position after I graduated. But it was just difficult to match up my school experience with working. I think I would have stayed with it if they offer some sort of an apprenticeship type system, where you're kind of putting what you're learning into practice almost immediately.—White Female – 5th Year (P10)

Conclusion

Internship and co-op experiences can play a key role in female students' undergraduate engineering programs, as well as in their decisions whether to persist. They often influence students' perceptions of the engineering field and their career options and decisions^{1,3-7}, as well as their academic and post-graduation outcomes.⁸⁻¹⁰

This paper contributes to existing literature focused on engineering internships and co-ops by examining the role that these work experiences play specifically for female engineering undergraduates. The paper explores how internships and co-ops influence female students' understanding of the field, their networking opportunities, and their confidence and motivation to persist in engineering. It also sheds light on some distinctions between *stayer* and *switcher* experiences.

Students talked about how much they learned about the real working world of engineering from their internships and/or co-ops. They viewed this kind of learning as contributing greatly to their understanding of the kind of work they would be doing post-graduation, as well as the kind of work they would not be expected to do, and how the work related to and reflected what they were currently learning in coursework. Further, they appreciated having the opportunity to apply what they were learning in classes to real-life situations and problems. This provided them with genuine problem-solving experiences that allowed them to develop additional skills that would be useful in the professional realm, such as communication and collaboration skills.

Stayers, in particular, described internships and/or co-ops as providing them with various networking opportunities. In some cases, these relationships took the form of mentorships, where the engineering professionals advised students on both current work and future plans. These connections not only provided female *stayers* with professionals to turn to for information and support, but also connections they could tap in the future when seeking employment. In other

words, these experiences helped them develop the kind of social capital that could be particularly helpful in their future engineering pursuits.² In fact, some *stayers* reported that they had already secured a job (i.e. post-graduation or additional internship or co-op) as a result of their work experiences.

Many *stayers* expressed that their confidence increased as a result of participating in internships or co-ops. They explained how through the engineering-related work experience they realized that they were able to do the work, something they may have questioned at other times during their program. They also described how their work experiences reaffirmed how much they had learned in their programs, and when they compared their skills and knowledge to other interns they worked with, they realized how well-prepared they were. All of these factors contribute to students' development of the *professional role confidence* needed to become successful professionals.⁵

Both *stayers* and *switchers* found that their internship and/or co-op experiences provided them with motivation to continue in their engineering programs. They enjoyed being able to do project-based work, and they appreciated having a break from classes, getting paid, and having fun during the process. *Stayers* in particular, expressed how their internship or co-op confirmed their interest in engineering and validated their coursework, which provided them with additional motivation. Students also reported realizing the different options available within their field, as well as honing in on and pursuing specific interests based on these work experiences. This motivation speaks to students developing *career-fit confidence*, whereby as a result of these experiences, they determine that the engineering profession is one that will be appropriate for them and will provide interesting and worthwhile employment.⁵

While two of the *switchers* were only motivated to continue in their engineering programs for a limited time, they nonetheless reported that they stayed in engineering longer than they otherwise would have as a result of their internship or co-op experiences. The other *switcher* recounted how her experience helped her decide to leave engineering, which could indicate a drawback of such experiences, whereby students can develop a limited or distorted perspective based on a single experience that strongly sways their career decisions.^{1,30-32} Another distinction between the *stayers* and *switchers* is the proportion of each group that reported experiences with internships or co-ops during the interviews. In total, three of the 21 *switchers* (14%) were interviewed for the larger PACE study described their experiences with internships or co-ops while 24 of the 66 *stayers* (36%) did the same. Given the general positive impact of the engineering work experiences described in this paper, one wonders if the retention outcomes would have been different for the *switchers* if more had experienced internships and co-ops.

The fact that the female students in our sample who described having internship and co-op experiences were predominantly white draws attention to why this may be the case. While our study and other research indicates that students can develop social capital as a result of participating in internships and co-ops, it raises the question of whether particular social and cultural capital are needed to get an internship or co-op.² Given that internship and co-op experiences generally benefit female students and contribute to their learning, confidence, motivation to persist, and career prospects, it would be important to develop a deeper understanding of what prohibits some female students, especially women of color, from

participating. Given that two *switchers* alluded to the fact that they may have stayed in engineering if their school had offered some sort of apprenticeship-type system, future research could explore how schools might encourage more female students to stay in engineering by integrating more apprenticeship-type experiences into their engineering programs.

Internships and co-ops provide a variety of benefits to female undergraduate engineering students. They enhance students' learning, connect students with professionals in the industry and provide a *taste of the future*, all of which contribute to female students' confidence—both professional and career-fit—which ultimately influence female students' decisions to persist to graduation and pursue a career in engineering. Therefore, engineering schools would benefit from making internships and/or co-ops an integral part of their undergraduate programs.

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