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Paper ID #16968

The Effect of Cooperative Education on Retention of Engineering Students & the Transition to Full-Time Employment

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Abstract

This study expands on the findings from an NSF (GSE 0827490) funded study entitled "Pathways to Self-Efficacy and Retention of Women in Undergraduate Engineering" which investigated reasons for low representation and retention of women in STEM fields. In this paper, we report on qualitative analysis from a recent pilot study involving in-depth interviews from five engineering students in their final academic year of study and a set of five engineers interviewed within eighteen months of commencing their first full-time job in an engineering career field. All subjects previously completed several terms of cooperative education (intensive work study) within the same agency.

Interestingly, all five of the newly hired engineers interviewed strongly believed that their cooperative education (co-op) experience had helped prepare them for full-time employment. Additionally, all strongly conceded that these experiences specifically helped ease the transition from student to professional. Although three out of five agreed that their college courses provided them with technical skills they could use in the engineering field, only two felt as though they had adequately developed the soft skills in college that they needed for full-time employment. Notably, all mentioned that their co-ops provided opportunities to meet and work with active role model(s) which aided in the development of self-confidence.

All five of the engineering students graduating within the next academic year who were interviewed mentioned that in general co-op at least partially hindered their academic performance. They cited a positive experience with employers and the knowledge that they had likely secured a full-time job upon graduation as the reason for a decrease in academic drive. Impressively, all five students stated that their co-op experiences increased their perceived level of ability to be successful in their work roles. It is worth noting that although it was not specifically asked of them, at least three of the ten interviewees mentioned the difficulty they experienced during the transition between co-op and school.

This paper will delve into the findings of this initial pilot study and will draw reasonable conclusions from the data. We also gathered information about which types of interview questions are helpful in gaining useful insights into how cooperative education impacts retention in undergraduate engineering programs and a student's transition to full-time employment following graduation.

Keywords-Engineering; Cooperative Education; Retention; Academic Self-Efficacy; Work Self-Efficacy

Introduction

The initial study "Pathways to Self-Efficacy and Retention of Women in Undergraduate Engineering", also referred to as Pathways I, was supported by the National Science Foundation Research on Gender in Science and Engineering program grant and collected data from four

separate universities: Northeastern University, Rochester Institute of Technology (RIT), University of Wyoming, and Virginia Polytechnic Institute and State University (Virginia Tech). RIT and Northeastern have formal cooperative education programs while University of Wyoming and Virginia Tech do not and consequently only a small percentage of students (2% and 10% respectively) participate in voluntary co-op programs at these two universities. The purpose of that study was to investigate the concern over a lower percentage of women participating in science, technology, engineering, and math (STEM) fields which consequently translates into a lower percentage of females in these areas of the work force.[1] The study examined whether retention of students in engineering majors could be improved through a student's self-efficacy and to what degree contextual support services could impact retention rates for both male and female students. Self-efficacy, defined as the perceived degree of self-confidence a person feels towards their ability to complete a given task [2], was predicted to explain why participation in cooperative education improves retention in engineering fields. The prior study discussed three main measures of self-efficacy for engineering students; academic self-efficacy, work self-efficacy, and career self-efficacy. Academic success was shown to enhance an individual's self-efficacy in this area while cooperative education was the main influence on work self-efficacy for students who participate in these programs and finally, all forms of self-efficacy were enhanced by academic support.[3]

The research conducted in the current study employs a qualitative approach to add depth to the original Pathways I findings by showing substantive understanding as to how cooperative education experiences are critical to improving the self-efficacy of undergraduate engineering students. By gaining insights into the lived experiences of the co-op we can better understand the ways in which students experiment with career options before entering a given field and learn how to interact in a professional working environment. So, our study investigates the experiences of engineering students and newly hired full-time engineers who have participated in cooperative education programs and promote further discussion and research on the benefits and limitations of such programs. By using a qualitative interview-based approach, our goal was to further refine and build upon findings from the quantitative Pathways I study. Quantitative studies do not allow for the more in-depth, nuanced accounts of human behavior that are likely accessible through qualitative approaches.[4] Furthermore, Pathways I relied on a data pool composed predominately of male students and did not involve questions specifically regarding the experiences of women. Extending interviews to include engineers in their first eighteen months as full-time employees serves to gain valuable insights into if and how co-op experiences impacted their decision to remain in their respective undergraduate engineering programs. Interview questions for the pilot study were formulated in part by examining a set of key issues including:

1. Examining whether co-op helps women in particular decide affirmatively about their perception in an engineering career.
2. Investigating the pervasive effect of work self-efficacy on both academic and career retention through co-op.
3. Exploring the persistent question among non-co-op schools whether there may be a substitute for the salutary impact of co-op.

4. Probing the critical impact of contextual support on women undergraduate students.
5. Following up on the material influence of academic self-efficacy on career success after graduation.
6. Probing the factors that enhance the assimilation of alumni into the workforce.

Methodology

Although a small sample size was utilized, pilot studies of this nature are necessary when learning about new areas and understudied populations.[5] Testing interview questions on a smaller scale allows for the formulation of clear, concise questions which can draw insights that can be built upon in future studies. The data pool for this study includes a total of ten individuals. The subjects represented a wide variety of universities in regards to size and geographic location, and included both private and public universities. Some of these universities have a well-established cooperative education program while others do not have a program at all. Data were also collected on each subject's hometown. These data were not directly utilized for this study but were collected with the idea that moving further from home for college could have some impact on personal development and individual experiences. Eight of the ten subjects reported a hometown in a different state or country from the state they completed co-op assignments in and three subjects grew up in a different state than the state in which they attended college. The sample included one electrical engineer, two mechanical engineers, four aerospace engineers, and a total of three subjects who reported a mixed major of mechanical and aerospace engineering. All subjects completed a minimum of three co-op rotations at this particular agency while several also completed additional co-ops and internships at other organizations.

Participants

Five of the ten individuals interviewed for this pilot study were undergraduate students within nine months of graduating with a Bachelor's degree in engineering. The undergraduate sample was comprised of three women (60%) and two men (40%). All interviews were conducted in person by the same interviewer and were recorded without reference to the subject's identity. The average age of undergraduate participants was just over twenty-four years old with the youngest subject at twenty-one years old and the eldest subject in his early thirties. The average grade point average (GPA) of the undergraduate subjects was 3.45 on a 4.0 scale. As a note, undergraduate subject three had already completed her undergraduate degree and was enrolled in a dual-degree type program where she was within nine months of graduating with a Master's of Science degree in mechanical engineering.

The other five subjects were newly hired engineers who had all begun working in the field within the last eighteen months from the time interviews were conducted. This sample also included three women (60%) and two men (40%). Interviews were conducted in the same manner as the undergraduate interviews with a minor exception. Two interviewees who could not be reached for an in-person interview e-mailed their responses and care was taken to disassociate their name from the responses. The average age of the full-time subjects was just shy of twenty-six years old and the average GPA reported by the full-time engineers upon graduation was 3.4 on a 4.0 scale.

Interview Protocol

The first author conducted all the interviews which ranged from ten to twenty minutes in length. Table 1 outlines the interview questions asked of each respective group.

Table 1: Interview Questions

Question Number	Undergraduate Engineering Students	Full-Time Engineers
1	Do you feel as though your academic performance has been influenced by your co-op experience(s)? How about the extent to which your academic performance has been affected by your co-ops? For women only**:** Have your co-op experiences had any effect on your viewpoint as a woman in engineering?	How adequately do you feel your co-op experiences prepared you for full time employment? In what way did these experiences make the transition to full time employment easier or more difficult? Did your co-op experience(s) allow you to see women/men who could serve as role models or mentors to you? Do you feel as though these women/men influenced your decision to persist in the engineering field?
2	Have your academic and career goals changed over the course of your co-op experiences and if so, how?	Do you feel as though your co-op experiences had an effect on your academic success? On your desire to persist in engineering? On your ability to find a full-time job after college? On your success or lack of success in fulfilling tasks on the job?
3	What college experiences do you feel have been most influential in keeping you in an engineering major? What has been the impact of co-op on your persistence in engineering?	Can you explain how your academic and co-op experiences combined to prepare you for your current job in engineering? Your potential career in engineering?
4	Which items from the following list do you feel your co-op experience(s) have helped to further develop your self-confidence in dealing with?: • Understanding what is expected of you at a full-time job • Working in a team • Time management/ability to manage multiple tasks at once • Understanding the culture of an organization and how you fit in it • Knowing how to solve new and difficult engineering problems • Performing engineering tasks that were not covered in the classroom • Understanding how to be sensitive to others' differences Do you think the self-confidence (if any) you developed as a result of the items previously listed have had an impact on your decision to stay in the field of engineering? What do you think was the most beneficial aspect of your co-op experience(s)?	
5	Did any aspect(s) of your co-op experience(s) discourage you? If so, how did you overcome that?	

Subjects were selected using a snowball sample approach and interviews were conducted in the privacy of the subject's office with the exception of the two engineers who submitted their responses over e-mail. While the interview questions were pre-determined, the questions were intended to be open-ended so that informants could freely add to the discussion. Questions where grouped into five major categories: 1) Thoughts on how their academic performance was influenced by their co-op experience, 2) Academic and Career Goals, 3) Influence of collegiate experience on selection and retention in their major field of study, 4) Aspects of their co-op experience that contributed to the development to their self-confidence and 5) Negative impacts of their co-op experience. Although specific questions were asked of each subject, all comments were welcomed as there is much to be gained from subjective interpretations to the interview questions rather than standardized responses which are more common in quantitative data collection.

Data Analysis

The resulting data were analyzed using the Gioia method [4] which is a systematic approach for progressing from raw data to themes and conclusions of qualitative data. This methodology suggests breaking down data into broad first order categories. This step generally results in a number of categories which can often be overwhelming and make it difficult to decipher the main ideas. From here, similarities and differences in these categories were identified to create a much smaller list of second order themes which can then be broken down even further if need be.

Initially, each individual's responses to each interview question were assigned numbered codes which corresponded to a key listing of different first order concepts. This process resulted in thirty-six rather broad thoughts which were combined into more inclusive groups recurring among subjects. This process resulted in seven emerging themes. These resulting second order themes were what would become the five major themes which Gioia refers to as aggregate dimensions.[4] A sketch of this process, modeled after the Gioia method, is shown in Figure 1. The numbers in the parentheses show the quantity of items resulting in each category (1st order, 2nd order, final main themes) as data analysis took place.

Findings

The following results of this pilot study are broken down into five main themes: Influence of Co-op on Academic Performance, Transition between Cooperative Education and Academic Studies, Influence of Co-op on Work Self-Efficacy, Influence of Contextual Support & Role Models on Academic & Work Self-Efficacy, and Transition to Full-Time Employment. A discussion of additional interesting findings follows and reports on responses specific to female subjects, differing perspectives from non-traditional students, and undergraduate perceptions of the most beneficial aspect of co-op.

Influence of Co-op on Academic Performance

Interestingly, all five undergraduate subjects felt as though co-op actually hindered their academic performance to some degree. This was often attributed to a positive employer review

which often served to convince students they would likely leave college with a full-time job offer from the company at which they had worked regardless of future academic performance. This equated to a lack of drive to excel academically upon return to university. However, students also knew they must continue to maintain a grade point average at or above 2.9 out of 4.0 to remain in this particular organization's co-op program and subsequently transition into a full-time position. Three of five subjects mentioned that although co-op did have some negative impact on academic drive, it also stabilized their performance due to two reasons. First, students were able to draw on experiences from a real world working environment while making connections to the lessons taught in the classroom and vice versa. Secondly, the GPA requirement to remain active in the cooperative education program at this organization acted to motivate these students to remain diligent in their studies. This was demonstrated in Pathways I which showed that initially a high GPA led to elevated academic self-efficacy which in turn had a further subsequent effect on GPA. In effect, GPA and academic self-efficacy were self-sustaining and bidirectional. However, a single subject noted that academic drive was strongest before his first co-op assignment because he knew he needed to be competitive against others seeking to secure work experiences with highly competitive employers. Although co-ops appeared to hinder relative academic performance it appears as if these students did just fine academically but it is possible that they could have done even better.

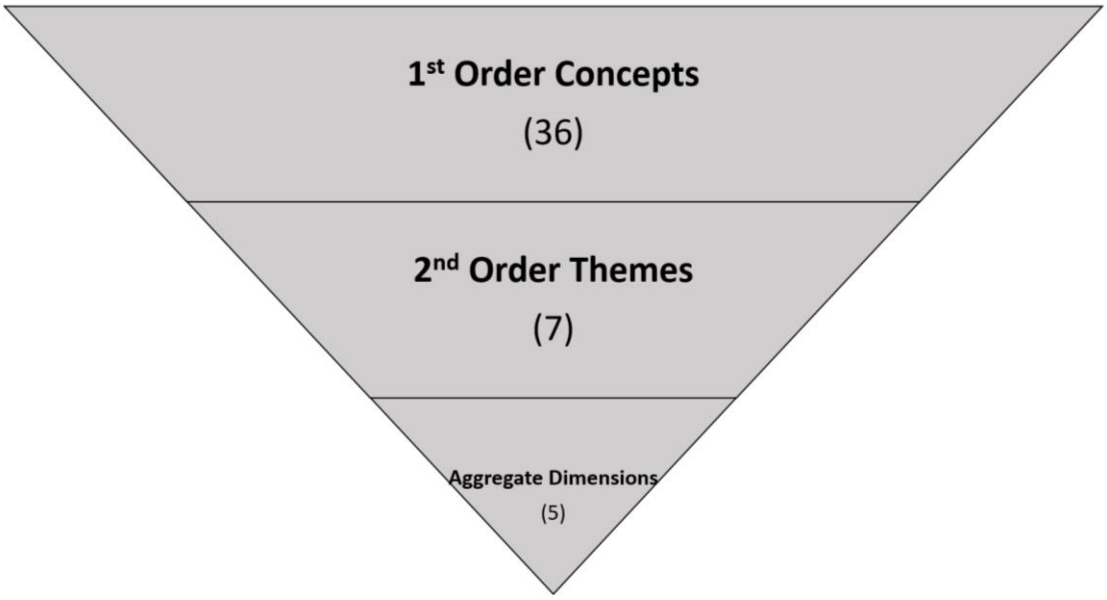

Figure 1: Data Analysis, Modeled After the Gioia Method [4]

Past research has shown that co-op students generally maintain higher GPAs than students who do not participate in cooperative education programs. The average undergraduate GPA of all subjects for this particular study is 3.45 which is noticeably higher than the 3.3 average GPA outlined for students having completed two or more co-ops in the Pathways I study.[1] This GPA is notably higher than the average 3.0 weighted GPA customary of students not having participated in co-op programs. However, in the Pathways I study the student GPA was self-reported and then confirmed using official records. Self-reported GPA often decreased

following record based adjustments. In the pilot study, the GPA was self-reported and the attributed differences could partly be explained by inflation through self-report.

This GPA difference could also be attributed to the notion that many of the most competitive employers place minimum grade point average restrictions on their co-op positions which serves as a driving factor for students to excel academically. Likewise, this could also be attributed to increased academic self-efficacy resulting from the co-ops themselves which increases a student's perceived ability to apply what they have learned to subsequent coursework.

Three of the five full-time subjects stated that co-op improved academic performance while no one mentioned co-op explicitly hindering academics for the reason cited earlier. Furthermore, all full-time subjects believed that their academic programs equipped them with at least a portion of the skills that would help make them successful in the workplace. It is an interesting point that full-time engineers did not recall a decrease in academic performance while enrolled in cooperative education programs while all undergraduate subjects mentioned at least some negative impact of co-op on their academic drive though not to a material extent. Undergraduate subjects were also not as likely to recognize the quality of education provided by their respective institutions in adequately preparing them for full-time employment to the degree that newly hired engineers did. It is possible that once removed from their undergraduate institutions, individuals were able to look back more subjectively and in turn more favorably on their undergraduate education than those who were currently enrolled. Furthermore, undergraduate students likely eager to complete the degree program and put their skills to use in the field were probably more likely to overlook the quality of the education they were currently receiving.

Perhaps most noteworthy is that positive co-op experiences were cited most frequently as the prime motivation for persisting in an engineering major, potentially serving as an indication of their reported increase in academic self-efficacy. Past research supporting this idea has found that co-op often has a positive impact on students' academic performance and their persistence in graduating. [6 7 8 9 10] A common feeling for these students was "I just want to graduate and start working!"

Transition between Cooperative Education and Academic Studies

Although none of the interview questions specifically aimed towards gaining information about an individual's transition between co-op and school, an interesting theme emerged in the qualitative analysis. Two undergraduate subjects and one full-time engineer subject mentioned experiencing difficulty in this transition. One explanation was the lack of stability brought about by the transient nature of many co-op students which often requires leaving behind hometowns, colleagues, and friends. A second commonly cited explanation was the need to recall information in college courses after having been removed from academics for extended periods of time. This last point could prove particularly challenging for students who attend schools which do not support formal cooperative education programs and thus do not regularly offer a course schedule conducive to students participating in co-op. For one undergraduate subject, difficulty ensued when she was expected to pick up where she had left off in between two courses intended to be taught in a simultaneous sequence after returning from a one year hiatus due to co-op.

Furthermore, previous research suggests feelings of alienation resulting from a lack of opportunity for students returning from co-op to apply the new knowledge they have gained to the classroom. [11] [12]

While a difficult transition back to school would appear to negatively impact retention, it actually proved to be added motivation to remain in an engineering program due to the enticement of future co-ops where subjects generally felt as though they were able to contribute impactful engineering work. This supports the Pathways I finding that number of co-op rotations is the number one variable in predicting retention of engineering students. With this being said, students returning from co-op historically have recorded a reduction in their opinion of professors' effectiveness. These thoughts likely stem from the purely academic background of some faculty members as well as the realization that classes are not the only places in which students can learn new information.[3]

Influence of Co-op on Work Self-Efficacy

Interview questions relating to work self-efficacy for this study sought to dig deeper on findings from Pathways I. The aforementioned study found this category of self-efficacy measures the student's confidence in his or her ability to work in teams, demonstrate sensitivity towards others, handle office politics, and deal with pressures related to engineering tasks handed to them. These measures are also requirements for success in a professional working environment.[3]

Not surprisingly, positive co-op experiences provided students with a heightened sense of work self-efficacy. This occurred when students were able to feel as though they made valuable contributions to the team in which they were working. This aligned with the Pathways I study which also concluded that the extent to which a work assignment allowed a student to feel as though they were part of the team also played a role in impacting work self-efficacy.

Three of the five subjects cited an increased level of responsibility granted to them on co-op improved their level of work self-efficacy. This increased self-efficacy resulted from a range of responsibilities including time management development, the ability to explain technical engineering projects to those unfamiliar with them, as well as serving as the lead engineer on projects.

Two of five undergraduate subjects referred to a particular experience which discouraged them from continuing in the engineering field. One subject experienced a negative first work assignment which ties back to the importance of quality work assignments for engineering students and the importance of feeling like part of the team. This subject mentioned that her group "set me up pretty poorly…with how it was run. So that was kind of discouraging because I could not show up and no one would notice. So I hated that." She mentioned that she overcame her negative feelings about the group by proactively seeking information from others in her group and learning all that she could about what they do. This effort was recognized by her managers at the end of the assignment she was praised for her hard work despite the circumstances. The second subject mentioned that although she did not necessarily agree that "discourage" was the correct term in regards to the impact of any particular co-op experience on

her continuation in the engineering field, she noticed "a small group of people who are just really tough and strict and it almost feels as though they want you to prove yourself to them before they give you some sort of approval. At first I was discouraged because I didn't know what to do about it." She felt as though as a young engineer she needed to prove herself to particular colleagues before gaining their respect. Although these two subjects were able to make the best of their situations, this shows the importance of meaningful, constructive work assignments in ensuring cooperative education continues to have a positive impact on work self-efficacy in students.

Influence of Contextual Support & Role Models on Academic & Work Self-Efficacy

Support is considered contextual in nature when mediated through the situation at hand. For instance through financial aid to those in need as well as career choice encouragement or discouragement. Contextual support can also be conveyed through modeling and conversation with parents, role models, peers, and friends that send messages about a student's efficacy. [13] [14] [15] Pathways I found that contextual support often translates into academic, work, and career self-efficacy particularly for women. Student sections of industry clubs and professional organizations such as the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Lunar Lion Team at Penn State, and the National Society of Black Engineers provided the students interviewed here with a heightened sense of academic and work self-efficacy. These organizations afforded students valuable opportunities to meet like-minded engineering students, learn about important industry news, and serve as mentors while providing outlets to employ technical skills taught in the classroom.

Although only the full-time engineer data pool was asked specifically about whether their co-op experiences allowed for an introduction to role models and mentors in the field, many of the interviews for both data pools touched on this topic. For female subjects, a strong presence of successful women in the workplace played an instrumental role in increasing self-efficacy. Both male and female subjects cited the benefits of working alongside professionals with which they could personally identify. These interactions often served to show a subject that if someone like themselves could succeed in the field then so could he or she. Although the subjects were questioned regarding same sex role models, several of them specifically pointed out that they encountered both men and women who served as valuable role models to them.

Transition to Full-Time Employment

All undergraduate subjects agreed that some aspects of co-op helped them better understand what would be expected once the transition to a full-time engineer occurred. Positive work experiences often reinforced a student's belief that he or she could succeed in an engineering career field as well as helped to guide the individual towards the type of career within engineering that would be most satisfying. Two subjects also noted that although a particular co-op experience might not have been the most favorable, it helped him or her recognize the type of engineering career that he or she did not want to pursue which was in some cases as beneficial as a more positive co-op experience. Interestingly, at least two subjects cited positive co-op experiences as the reason for the decision to pursue full-time employment

immediately following undergraduate graduation in place of an original plan to continue into graduate studies. The subjects stated two reasons for these change in plans. First that for the career field they had chosen to enter, an advanced degree was not necessary and/or was not particularly useful. The added fear that turning down a job offer to instead attend graduate school would account for a lost opportunity with that employer in the future was cited as an additional reason for a change in academic and career plans.

Not surprisingly, full-time subjects all agreed that their previous co-op experiences specifically helped eased the transition to full-time employment as an engineer. These experiences not only helped prepare young engineers so they knew what to expect and equipped them with the confidence that they could complete the tasks expected of them on the job, but often times many of the skills required for the position had already been introduced and honed while on co-op. The notion that the individual had already gotten many of the mistakes expected of a young engineer out of the way while on co-op was also presented.

Other Interesting Findings

Two out of three female undergraduate subjects felt a noticeable lack of women in their college engineering courses. These two subjects mentioned challenges facing women in a field dominated by men, often feeling out of place in a classroom full of males. These two women also expressed moments of doubt about their ability to persist in their respective engineering majors. The third female subject mentioned that she did not notice the stereotype of a lack of women in engineering but attributed that to a larger percentage of women in engineering at her university. This particular academic institution has a female engineering undergraduate enrollment more than ten percent over the national average. [16] As noted previously, all female subjects stated that working with other successful women in the workplace helped to curb some of the negative thoughts resulting from a low representation of women in the classroom, likely positively impacting their self-confidence. These women, often working in leadership positions, served as role models and mentors during co-op which helped to encourage the students' persistence towards an engineering degree. Although Pathways I did not focus specifically on female role models, these findings align with results of prior studies which have found that women tend to experience lower academic self-efficacy than their male counterparts without reporting lowered levels of work self-efficacy.[3] Furthermore, this demonstrates the importance that co-op experiences allow female students in particular, access to an adequate sample of role models to help them further acclimate in the workplace.

Individuals who came into college with a strong sense of confidence that they wanted to be engineers, and would succeed in an engineering field, seemed to struggle less with self-doubt along the way and in some ways mentors and role models were less impactful and important as a source of reinforcement for these individuals. This was particularly apparent for a non-traditional undergraduate student in his early thirties who had served in the military prior to entering college. This subject was by far the most confident in his ability to persist and succeed in an engineering major and career field. Co-op served primarily to make him more comfortable by allowing him experience with the type of work he would be doing as a full-time engineer.

As discussed previously under the theme of work self-efficacy, the quality of co-op experiences is particularly important. The impact of a co-op experience on an individual is most profound if an individual feels as though he or she is able to contribute something of importance to the team.[3]

Table 2 shows the responses for each of the five undergraduate subjects when asked about the most beneficial aspect of his or her co-op experiences. Perhaps most interesting is that one subject felt much more receptive to learning in a work environment that in the classroom. One explanation may be that a workplace environment allows for a more hands-on learning experience in contrast to the more theoretical and lecture based learning that occurs in the classroom. The climate of the learning environment is probably important as well. Although it is likely that both men and women share this view, it is possible that as a woman, this subject felt more receptive to learning in an environment where she saw other women like herself doing similar work. In future research it may be helpful to ask questions which help draw more information on this view. For example the question "What factors do you feel influenced how much you learned on co-op?" could be asked.

Table 2: Undergraduate Responses for Most Beneficial Aspect of Co-op

Most Beneficial Aspect of Co-op
Knowing what to expect when you enter the engineering field directly out of college and being able to verify that this is in fact the type of job you want
1) Understanding the importance of networking 2) Being able to bridge the gap between theory and practice by applying what you learn in school to a real world experience
The wide variety of things she got to work on during work assignments because she feels more receptive to learning in a co-op environment than as a student in the classroom
The experience itself because she never would have realized how much she enjoyed engineering if it hadn't been for those co-op experiences. She realized real world engineering is so different than what happens in the classroom.
The self-confidence that the experiences helped to develop

Discussion

This pilot study provides a starting point for a supplemental qualitative approach to the quantitative Pathways I study. Ultimately, qualitative data needs to be collected from a larger and more diverse sample to ensure that these findings hold true for co-op students at a wide variety of organizations and for students at different points in their academic careers. Unlike the pilot study, Pathways I did not involve input from newly hired engineers. Including the perspective of this group allowed for additional insight into the benefits of formal cooperative education programs as part of the curriculum and its role in aiding the transition from student to full-time engineer. In addition, Pathways I relied on a data pool composed predominately of male students and did not involve questions specifically regarding the experiences of women whereas

the current pilot study included a question and involves a predominance of women among its subjects.

Based on prior findings from the Pathways I study, an unexpected outcome of the pilot study is the potential effect of one type of self-efficacy, namely work self-efficacy, on another, academic self-efficacy. Self-efficacy literature traditionally has not explored the effects of one type of self-efficacy on another. Research done on working mothers, however, has shown that different aspects of one's work and home lives may contribute to an increase in work self-efficacy and a decrease in maternal self-efficacy and vice versa. This research found that feeling like a good mother had the potential to boost one's work self-efficacy because there is a lot of overlap between the two roles. [17] Is it possible to draw a similar connection between work and academic self-efficacy in engineering students? Is it possible that an increase in work self-efficacy as a result of co-op experiences sustained students through the periods back at school where there was not a significant increase in academic self-efficacy thus positively impacting retention? Although it is particularly interesting that students felt an overall decrease in academic drive, it is somewhat unclear as to whether or not this had any connection to a change in levels of academic self-efficacy. Further investigation into a connection between the types of self-efficacy discussed here has particularly valuable potential.

An emerging result from this study and unexplored in the Pathways I focuses on the student transition between co-op assignment and school. Although none of the interview questions were intentionally designed to probe this topic, the theme emerged during data analysis. While a difficult transition back to school would appear to negatively impact retention, the enticement of future co-ops involving impactful engineering work added motivation to remain in an engineering program.

Predicted outcomes of the pilot study based on the Pathways I findings related to work self-efficacy where positive co-op experiences provided students with a heightened sense of work self-efficacy when students felt that they made valuable contributions to the team in which they were working. This aligned with the Pathways I study which also concluded that the extent to which a work assignment allowed a student to feel as though they were part of the team also played a role in impacting work self-efficacy. An additional predicted outcome reinforced the Pathways I finding that contextual support translates into academic, work, and career self-efficacy particularly for women. In the pilot, although only the full-time engineers were asked specifically about whether their co-op experiences allowed for an introduction to role models and mentors in the field, many of the engineering students also touched on this topic. For female subjects, a strong presence of successful women in the workplace played an instrumental role in increasing self-efficacy. Both male and female subjects cited the benefits of working alongside professionals with which they could personally identify and several of them specifically pointed out that they encountered both men and women who served as valuable role models to them.

An area of future investigation will seek to better understand the following. Can work self-efficacy, considered to be so vital to mobilizing the positive results from co-op experience, be brought out in other experiential activities such as capstone projects, undergraduate research, and even experiences within the classroom environment? Answers to this question could benefit

engineering schools with an active co-op program in helping faculty and academic advisors coach and inform first and second year students as to best ways to prepare for obtaining a competitive first co-op assignment. What experiences can a student engage in before obtaining that first co-op that will begin to build work self-efficacy? The answer to this question could also benefit those at engineering schools with less developed co-op programs.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant GSE 0827490. The researchers wish to express their gratitude for the support of this project. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

[1] Raelin, J. A., Bailey, M. B., Hamann, J., Pendleton, L. K., Reisberg, R., and Whitman. D. L. (2014). The gendered effect of cooperative education, contextual support, and self-efficacy on undergraduate retention. *Journal of Engineering Education*, 103(4), 599-624.

[2] Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.

[3] Raelin, J. A., Bailey, M. B., Hamann, J., Pendleton, L. K., Reisberg, R., & Whitman, D. L. (2015). The role of work experience and self-efficacy in STEM student retention. *Journal on Excellence in College Teaching*, 26(4), 29-50.

[4] Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research notes on the Gioia methodology. *Organizational Research Methods*, 16(1), 15-31.

[5] Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook. Sage.

[6] Davie, R. & Russell, J. (1974). Academic performance and work experience: An Australian cooperative experience. *Journal of Cooperative Education*, 10(2), 1-12.

[7] Gardner, P. D., Nixon, D. C., & Motschenbacker, G. (1992). Starting salary outcomes of cooperative education graduates. Journal of Cooperative Education, 27(3), 16-26.

[8] Lindenmeyer, R. (1967). A comparison study of the academic progress of the cooperative and the four-year student. *Journal of Cooperative Education*, 3(2), 8-18.

[9] Smith, H. S. (1965). The influence of participation in the cooperative program on academic performance. *Journal of Cooperative Education*, 2(1), 13-23.

[10] Somers, G. (1986). How cooperative education affects recruitment and retention. *Journal of Cooperative Education*, 25(1), 72-78.

[11] Mann, S. J. (2001). Alternative perspectives on the student experience: Alienation and engagement. *Studies in Higher Education*, 26(1), 7-19.

[12] Auburn, T. (2007). Identity and placement learning: Student accounts of the transition back to university following a placement year. *Studies in Higher Education*, 32(1), 117-133.

[13] Arbona, C. (2000). The development of academic achievement in school aged children: Precursors of career development. In S. D. Brown & R. W. Lent (Eds.), *Handbook of counseling psychology* (3rd ed.; pp. 270-309). New York, NY: Wiley.

[14] Marra, R. M., Rodgers, K. A., Shen, D., & Bogue, B. (2009). Women engineering students and self-efficacy: A multi-year, multi-institutional study of women engineering student self-efficacy. *Journal of Engineering Education*, 98(1), 27-38.

[15] Zeldin, A., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technical careers. *American Educational Research Journal*, 1, 215-246.

[16] Standford University, School of Engineering. Facts & figures. n.d. Web.

[17] Ladge, J. J., Clair J. A., and Greenberg, D. (2012). Cross-domain identity transition during liminal periods: Constructing multiple selves as professional and mother during pregnancy." *Academy of Management Journal*, 55.6, 1449-471.