STEM Experiences and Student Interest in Pursuing a Career in Engineering

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Abstract

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Of the Science, Technology, Engineering, and Mathematic (STEM) fields, women remain underrepresented in many engineering disciplines. Obstacles persist for entering the field via enrollment in an engineering program of study, but also for entering and remaining in an engineering profession. The push for more diversity and inclusion in STEM fields has led to many STEM enrichment programs, within and outside the school environment. These career-relevant learning experiences, both prior to and during university, influence students' perceptions and attitudes towards engineering. According to Social Cognitive Career Theory, individuals choose to pursue a career based on their skills and their expectations of the career, which can be influenced by external factors, such as participation in career-relevant learning experiences. To this end, I study the effect of pre-university engineering experiences and university extracurricular experiences on undergraduate students' perceptions of engineering and, ultimately, their decision to remain in the field. One hundred and ninety-four engineering students from Concordia University in Montreal, Canada responded to a survey about their pre-university and during-university career-relevant experiences, and their attitudes about the engineering profession. Results suggest that pre- and during-university engineering experiences are beneficial to engineering students, improving their self-efficacy and perceptions of the field. Engineering companies and educators may want to invest in these experiences if they want to support the next generation of future engineers and benefit from a more diverse workforce.

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Table of Contents

List of Figures and Tables

Figures

Figures in Appendix

Tables

Tables in Appendix

Introduction

"Only when the body of engineers truly reflects the society it serves – in terms of age, ethnicity, religion, physical ability, sexuality, and gender – can it most effectively serve the needs of society" – Puri, 2017, para. 18.

Science, Technology, Engineering, and Mathematic (STEM) fields have seen an increase in women's representation over the past years. Some of these fields, like biology and health studies, have experienced a faster growth rate of women representation than other fields, like computer science and engineering (Cheryan, Ziegler, Montoya, & Jiang, 2017; Shannon et al, 2019). However, the increase is numbers is only a first step, as women in more *gender-balanced* fields continue to face issues of inequality, such as holding lower positions and receiving less pay for equivalent work (Shannon et al., 2019). It has also been shown that women are more likely to leave STEM fields compared to men (Frank, 2019). Therefore, it is not only important to lower barriers of entry for women to enter STEM, but also to ensure their proper retention through equity and inclusion (Cheryan et al., 2017). Increasing gender diversity within organizations has proven to be beneficial, not only on a social basis, but on an organizational basis as well. When an organization embraces diversity, studies have shown that communication is improved, conflict is reduced, and creativity is enhanced (Dwertmann, Nishii & van Kippenberg, 2016; Kadam, Rao, Adbdul & Jabeen, 2020). The European Institute for Gender Equality (EIGE) produced a macroeconomic model which predicted positive economic impacts, such as increased employment and GDP growth, if the gender gap within STEM fields would be reduced within the EU (Morais Maceira, 2017). A positive diversity climate has also been linked to a reduction in discrimination and harassment, as well as an improvement in well-being and satisfaction (Fine, Sojo Monzon, & Lawford-Smith, 2020; Shannon et al., 2019). To add, as more STEM occupations become accessible and welcoming to women, women will have more access to high quality, well-paying jobs (Bert, 2018; Morais Maceira, 2017). The research on STEM diversity and inclusion must continue in order to identify and develop support mechanisms for women in STEM fields. However, as STEM fields widely differ from each other, it is wise to study the fields individually. This study chooses to focus on the field of engineering, a STEM field with one of the lowest percentages of women representation, and attempts to construct a better understanding of engineering at the undergraduate level, in order to better address the issues of women entering and remaining in engineering.

The engineering profession is so broad in terms of tasks, responsibilities, and career positions, that it is difficult to define what engineering is in a single sentence. In fact, many people – even engineers themselves – do not necessarily understand what an engineer is. Merriam-Webster's dictionary does not give much more information, defining an engineer as "a designer or builder of engines; a person who is trained in or follows as a profession a branch of engineering; and a person who carries through an enterprise by skillful or artful contrivance". Merriam-Webster defines engineering as "the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people". But engineering is more than just the application of math and science to design products. Engineers use their creativity to solve ambiguous and complex problems (Puri, 2017), constantly innovating and developing solutions to benefit humanity and improve society. They are not only responsible for the technology they create but are equally responsible for those who are affected by it (O'Gorman, 2021). Engineers are society's problem-solvers, with goals of creating a better and sustainable future (Study International, 2018). The problems engineers solve become more focused in each field. For example, biomedical engineers apply their knowledge and skills to the medical world, such as developing and testing new medical products and advising medical staff on the selection and usage of medical equipment (Moussavi, 2017). Chemical engineers use math, physics, chemistry, and biology to assist with the production of chemicals, foods, drugs, and other products (Bureau of Labor Statistics, 2022). Mechanical engineers oversee the process of designing, manufacturing, and testing a variety of products, such as climate control systems, automotive systems, robotic systems and so on (Bureau of Labor Statistics, 2021). Other types of engineering include civil, electrical, environmental, industrial, aerospace, computer, materials, health and safety, agricultural, marine and so on (Cote, 2021). With the engineering field being so vast, students are likely to find at least one aspect of engineering to be of interest to them (Study International, 2018).

Despite the fact that engineering is full of various prospects, enough to interest almost all individuals, women only represent 22.1% of all Canadian engineering graduates (Engineers Canada, 2020a). This percentage is reduced to 13.9% when looking only at the number of licensed engineers (Engineers Canada, 2020b). This low percentage of women disadvantages the engineering field, as it misses out on various perspectives and ideas that only a diverse group of people could provide. The push for more diversity and inclusion in engineering has led to many STEM programs, within and outside the school environment, attempting to remedy this gender gap. These programs are dedicated to getting young students interested in engineering and providing the support they need to enter and remain in a STEM field. Many of these programs attempt to showcase an inclusive engineering culture and integrate real engineering experiences in young students' lives. For example, Engendering Success in STEM (2022) implements interventions throughout a student's educational path, with the goal of creating an inclusive culture for both women and men. These interventions are separated into four stages: (1)

childhood, (2) adolescence, (3) university, and (4) early career, each dedicated to supporting women's representation in STEM. Interventions include summer camps, workshops, clubs, and community activities, all with the goal of promoting engineering, along with the other fields of STEM, and making it accessible to students. While Canada has seen a small increase in engineering graduates (both men and women), only 53% of them say they will definitely work in engineering as their future career (Engineers Canada, 2017). In the US, 40% of women engineer graduates never enter the workplace as an engineer or they eventually leave the engineering profession (Peters, 2017). So, while pre-university engineering programs have been put in place to encourage girls to study engineering, the engineering culture itself appears to be pushing them away.

Pre-university engineering programs attempt to promote a more modern view of engineering to attract students to the field, yet university courses are known to present more traditional, theory-based engineering content (Carberry & Baker, 2018). The difference between pre-university experiences and university courses can be explained as moving from an engaging and inclusive atmosphere to a technical and skill-focused environment (Lachney & Nieusma, 2015). Lakin, Wittig, Davis, & Davis (2020) believe the differences in these teaching perspectives can pose a problem, as there is a possibility for a "mismatch between what is promised in pre-engineering programs and what is delivered by engineering courses" (p.228). This 'mismatch' can lead to students leaving engineering while in school or opting out of the profession. The theory of met expectations demonstrates how an individual's expectations are related to their attitudes and behaviors within one's career (Wanous, Poland, Premack, & Davis, 1992). Expectations can have an effect on satisfaction, commitment, and intent to remain in a job or, in this case, within a field (Wanous et al., 1992). When choosing to pursue a profession, met expectations play a part in the decision. According to Social Cognitive Career Theory, individuals choose to pursue a career based on their skills and their expectations of the career (Lent, Brown, & Hackett, 1994). If the expectations displayed in university are not what is promised throughout pre-university engineering experiences, then it is possible that students will decide to not persist in the field. Engineers Canada (2017) reported that 12% of graduates who were unlikely to pursue an engineering career said it was due to the field "not [being] what [they]thought it was going to be" (p.16). Based on these facts, I believe that the problem of the retention of women in engineering actually begins before they even enter the workforce.

There is limited research on pre-university experience and its effect on students pursuing an engineering degree. Those who have experienced pre-university engineering activities may have a different perspective of the field compared to those who have not experienced any pre-university activities (Lakin et al., 2020). In addition, extracurricular activities related to engineering within university, such as internships and student affiliations, may also influence students' perceptions and attitudes towards engineering. This study intends to determine if taking part in career-relevant learning experiences, which includes pre-university experiences and during-university extracurricular activities, will influence a student's perception of engineering and, ultimately, their choice of remaining within the field. Additionally, I look at whether these experiences influence women in different ways than they influence men.

Theoretical Development

Social Cognitive Career Theory

This research is based within Social Cognitive Career Theory, a framework developed by Lent, Brown, and Hackett (1994) and founded in Bandura's (1986) Social Cognitive Theory. The framework extends Bandura's work regarding how individuals learn through experiences and interactions, to how individuals choose their career through learning experiences (Lent et al., 1994). The framework is split into three main variables – The first variable, *self-efficacy*, looks at the extent to which one believes in their ability to succeed at a given task or job. The second variable, *outcome expectancies*, looks at the consequences that an individual believes will arise out of pursuing said career. And the third variable, *goals,* is the result of an individual's self-efficacy and outcome expectations, which looks at how strongly one wants to do something. In this study, *goals* refer to the intent of pursuing and persisting in a career choice. In other words, Social Cognitive Career Theory (SCCT) posits that career choice depends on the extent to which people believe in their own capabilities and skills, and the degree to which positive outcomes are perceived to be likely to occur from pursuing the career (Lent et al., 1994; Lent et al., 2005). The combination of self-efficacy and outcome expectations is indirectly related to the person's goals through interest (Lent et al., 1994). When an individual positively judges their own abilities and believes positive outcomes will result from a career, their interest in the career is likely to be high, which in turn will increase their ambition in pursuing said career. By observing *self-efficacy, outcome expectations,* and *goals,* one can gain a better understanding of people's academic and professional choices.

Expectancy Theory

In addition to Lent et al.'s (1994) Social Cognitive Career Framework, part of my research relies on Vroom's (1964) Expectancy theory. Expectancy theory explains that motivation is a product of *expectancy*, *instrumentality,* and *valence*. In order for an individual to put effort into a performance, they have to believe that the effort will lead to a certain level of performance (expectancy), that they will be able to achieve expected rewards from that level of performance (instrumentality), and that the expected rewards are personally desired (valence) (Vroom, 1964). While SCCT considers outcomes that can be expected, the framework does not include if these outcomes are desired. Lent et al. (2003) simply describe positive engineering outcomes as *earning an attractive salary, getting respect from other people,* and *finding the work satisfying,* among other similar variables. However, by considering Expectancy theory, we understand that outcomes will vary in their attractiveness to different people. From a young age, children assign importance to certain outcomes and goals, creating their own subjective valuing of different achievements (Wigfield & Eccles, 2000). The value placed on these outcomes, along with the probability of desired outcomes occurring, determines whether individuals will be motivated to perform (Vroom, 1964). Therefore, while an attractive salary of a career may be highly desirable for one student, another may find it simply mediocre. In this case, the attractive salary may not be valued enough to motivate the student in pursuing said career, even though the attractive salary is inherently a "positive" outcome. The lack of determining what is considered as valued positive outcomes for students might be why some studies do not find any significant results with outcome expectancies and goals (Lent et al., 2003; Lent et al., 2005; Lent et al., 2007; Lent et al., 2008). For this reason, my study also considers students' own personal goal endorsements and if they align with what they expect they can achieve in an engineering career.

Literature Review

Career-Relevant Learning Experiences

Over the years, researchers have found many contextual factors influencing the SCCT framework. When Byars-Winston et al. (2010) studied engineering and biology majors, they found that self-efficacy and outcome expectations were both associated with academic goals and interest. However, engineering students' self-efficacy was only indirectly related to goals, through interest and outcome expectations, suggesting that other environmental factors were at play (Byars-Winston et al., 2010). Lent et al. (1994) explained that people's self-efficacy and outcome expectancies are influenced by their childhood and social environment. For example, as competence-related beliefs begin at a very young age (Eccles, Wigfield, & Schiefele, 1998), experiencing success and/or failure as a child can influence how individuals assess their abilities later in life (Wigfield et al., 2007). Children who experience failure during engineering activities, such as in science labs or projects, and who receive continuously negative feedback from their parents and teachers are unlikely to continue along the engineering path. Furthermore, much of the feedback students receive during their learning experiences more broadly aligns with gender stereotypes, communicating different expectations for girls and boys, such that girls are taught to focus on family and interpersonal relationships, and boys are taught to explore the more mathematical and scientifical subjects (Dasgupta & Stout, 2014). Contextual factors and events will also affect a person's learning experience, which, in line with SCCT, will influence their career interest and choice. Lent, Brown and Hackett (2000) refer to these factors as contextual supports and barriers, which are categorized as either distal or proximal. Distal influences are "background contextual factors that affect the learning experiences through which career-relevant self-efficacy and outcome expectancies develop" (Lent et al., 2000, p.37). These influences are found further away in time from when the individual is making a career choice. Such distal factors include school environment and learning experiences, which can have a direct influence on self-efficacy and outcome expectations (Lent et al., 2000). On the other hand, proximal influences are "contextual influences [that are] particularly important during active phases of educational or career decision making" (Lent et al., 2000, p.38). Proximal influences are closer in time to a choice action, such as one's social network and financial status at the point in time in which a decision is made (Carrico, Matusovich, & Paretti, 2019). These influences are at play during the time an individual makes a decision and can have a moderating effect on the relationship between interest and goals, as well as a direct effect on goals (Lent et al., 2000). Certain factors, such as family relationships, can have both distal and proximal influences (Lent et al., 2000). Previous studies have acknowledged the presence of these affordances. Lent et al. (2002) found several factors in a university that could influence one's career choice, such as direct exposure to work-relevant activities, vicarious exposure, and work conditions. Similarly, Byars-Winston et al. (2010) noticed that university environments may have an impact on students, as they found differences in self-efficacy, outcome expectations, and interest between students who went to a predominantly White university and those who went to a predominantly Black university. With a sample of science and engineering students, Stewart et al. (2020) noticed that self-efficacy differences were prevalent at the beginning of the semester, suggesting that variables outside of the course must have an impact on the students. Whereas personal factors, such as personality and intelligence, may contribute to self-efficacy differences, Stewart et al. (2020) noticed a significant difference specifically between genders, suggesting that men and women have different perceptions of their abilities (Vermeer et al., 2000), which is usually traced back to societal norms and beliefs (Marshman et al., 2018). Additionally, Inda, Rodriguez, & Pena (2013) found peer and family support to be environmental variables within the SCCT framework. In this study, I focus on the distal influence of career-relevant learning experiences, and I propose that students' experiences with engineering outside their current degree will positively influence their self-efficacy and outcome expectancies. These career-relevant learning activities are not present during the actual decision-making step, unlike proximal factors, but rather are what leads individuals to be interested or not interested in said career.

Students entering university already have set expectations and perceptions of their chosen academic discipline (Foor, Walden, & Trytten, 2007). Through childhood and early education, students form beliefs about activities and professions that follow them into university. In the case of engineering, it has been noticed that individuals, both young and old alike, hold poor or faulty views of the field, never having had a chance to properly learn about what engineers do (Carberry & Baker, 2018). As previously mentioned, engineering is not only about applying math and science, but rather a discipline that uses creativity and skill to help improve society by solving complex problems. This lack of awareness contributes to the naivety of engineering perceptions, where people think engineers work only with machinery or who constantly build rather than oversee projects (Cheryan, Master, & Meltzoff, 2015; Bays-Muchmore, 2018; Ozogul, Miller, & Reisslein, 2019). Studies have found that many of these misperceptions are held by elementary and secondary school teachers, which are then passed down to students (Hammack, 2016; Kilty & Burrows, 2019). Many young students who have expressed a disinterest in engineering blame the lack of compelling and relevant activities (Meija, Drake, & Wilson-Lopez., 2015; Aschbacher, Li, & Roth, 2010; Stevens et al., 2008). It is thus important to have career-relevant learning experiences, to support students in their abilities to succeed and to provide them with accurate information of the field, with the hopes of increasing students' interests in engineering. In general, it has been found that educational interventions, dedicated to facilitating learning and encouraging students to succeed, were found to positively influence students' self-efficacy, interest, and performance outcomes (Lazowski & Hullman, 2016; Rosenweig & Wigfield, 2016). To add, Aschbacher et al. (2010) traced many students' career interest to positive career-related experiences and social support. Morelock (2017) observed two types of engineering interventions that take place throughout one's education – accumulation of more engineering-related experiences and simulations of authentic engineering experiences. The first type of intervention includes any activity in which the student is expanding their knowledge of engineering, such as early education learning activities and case studies (Morelock, 2017). The second type of intervention allows students to experience actual engineering work, such as interactions with engineering professionals and clients (Morelock, 2017). Both types of interventions are important, as students develop a proper understanding of engineering and determine their interest towards the field. These activities also help improve students' skills and their self-confidence in working (Kanar & Bouckenooghe, 2021). Not only can these interventions occur prior to entering university, but they can also continue throughout one's university education.

Past literature has found that career-relevant learning experiences can be beneficial to students and their future career. These experiences can help increase students' self-efficacy and change students' misconceptions of a profession, by introducing activities that produce a more "positive and realistic view of [the student's] abilities and beliefs about college and the world of work" (Gibbons & Shoffner, 2004, p.96), impacting the students' interest and intent of pursuing a career. By introducing pre-university engineering experience to students in elementary school and high school, students can gain a more positive and realistic view of engineering.

Additionally, by continuing these experiences throughout university, through student groups and internships, students can observe how engineering really is through their eyes and hands-on experience, instead of just through course lectures and labs.

Pre-University Learning Experiences

Pre-university learning experiences introduce students to the world of STEM and help improve their abilities in math and science (Katehi, Pearson, & Feder, 2009). Such early education learning experiences include in-school programs, after-school clubs, summer programs, on-university-campus activities, fieldtrips, and school workshops (Ozogul et al., 2019). Some programs focus on STEM in general, teaching students all aspects of science, technology, engineering, and math, while other programs emphasize a specific part of STEM, such as engineering. Phelps, Camburn and Min (2018) noticed that simply taking high school engineering and technology courses would actually increase the likelihood of students entering STEM fields in university.

Pre-university learning experiences and outcome expectancies: Pre-university learning experiences, which, in this study, includes any activities associated with engineering whether at school or with family, will influence what a student can expect to achieve out of an engineering degree. Engineering is a complicated field, with many people unaware of what an engineer actually does. Studies show that people with little to no experience with engineering are seen having a simple and stereotypical understanding of the profession, usually influenced by media and pop culture (Cheryan et al., 2015; Carberry & Baker, 2018). People may assume being an engineer requires an inherent talent of mathematical and scientific skill and is someone who ‘builds and fixes’ things (Cheryan et al., 2017; Newley, Kaya, Yesilyurt, & Deniz, 2017). One common misconception is how engineering does not satisfy any communal goals. Communal goals are relationship-oriented values, such as collaborating with and helping others, as opposed to agentic goals which are achievement-oriented values, such as status and power. If elementary and high school teachers have this anti-altruistic image of engineers, they are likely to suggest students who are more relationship-oriented to avoid that profession – which, in line with stereotypical ideals, are more likely to be girls. Dasgupta & Stout (2014) explain that individuals are unaware of the communal values that can be achieved in STEM fields, especially in engineering, even though engineers promote the safety, welfare, and protection of the public and the environment, as they aim to benefit society through collaboration and solving real-world problems (Engineers Canada, 2016; Dasgupta & Stout, 2014). Career-relevant learning experiences aim to share this side of engineering, demonstrating how the field can not only serve agentic interests, such as achievement, but communal ones as well. Colvin, Lyden, & Léon de la Barra (2013) showed 5th graders how civil engineers can fulfill communal goals through a hands-on experiment, as they solved water transportation issues for underdeveloped countries. Similarly, students who were actively engaged in a National Science Foundation funded K-12 STEM education program were more likely to have realistic and positive ideas of engineering (Genareo, Kemis, & Raman, 2018). With a sample of Latino/a adolescents, Meija et al. (2015) implemented a community-based engineering design activity, in hopes of changing students' perceptions about engineering. After the intervention, students were more likely to associate engineering with designing and improving solutions, analyzing and investigating projects, and communicating and collaborating with a team of people rather than simply building and fixing things. Similarly, Aschbacher et al. (2010) noticed that students who took part in extracurricular science activities were more likely to see past STEM stereotypes, as they conducted hands-on experiences and interacted with real scientists. Having this previous experience with engineering activities would probably influence the way one perceives engineering once they get to university (Lakin et al., 2020). As, pre-university engineering learning experiences are geared towards being inclusive, engaging and active (Lachney & Nieusma, 2015), I hypothesize:

H1: Pre-university engineering experience and communal outcome expectations will have a positive relation for students entering university

Pre-university learning experiences and self-efficacy: Students who experience pre-university engineering activities are more likely to have higher self-efficacy. A student develops positive beliefs of their abilities through four sources – mastery experience, vicarious experience, verbal persuasion, and physiological states (Bandura, 1977). Career-relevant learning experiences can provide students with these sources of personal efficacy, as they allow students to learn and succeed with hands-on experience and real-world problems (mastery experience), show students how professional engineers perform their work (vicarious experience), encourage students that they can succeed (verbal persuasion), and mitigate any negative feelings of stress and anxiety (physiological states). Over a three-year period, Aschbacher et al. (2010) interviewed and surveyed students about their interest in science and engineering, as well as their self-confidence in said subjects. After analyzing students' responses across interviews and survey questions, the researchers noticed that by the end of high school, students who participated in extracurricular experiences, such as performing science labs or visiting hospitals, demonstrated an increase in their self-efficacy levels, as they were able to experience hands-on learning and develop an interest in the fields of STEM. Similarly, Meija et al. (2015) interviewed students before and after performing their community-based engineering design activity and asked whether the students were any good at engineering. Meija et al. (2015) noted an increase in the students' self-efficacy after the program was over, as students were now more likely to rate themselves as "pretty good" and no student had negative perceptions of their abilities. In the same manner, Ozogul et al. (2019) measured students' self-efficacy on a 3-item scale and found a significant increase in their self-efficacy after having participated in an engineering workshop. Although we have determined that engineering can mean different things to different people, the purpose of these extracurricular engineering experiences is to motivate all types of students and guide them towards an engineering path that is right for them. Pre-university programs are designed to support and encourage students in their ability to succeed. Therefore:

> *H2: Pre-university engineering experience and self-efficacy levels will have a positive relation for students entering university*

Extracurricular Learning Experiences

Stevens et al.'s (2008) case study of Simon, an engineering student at a large public university, demonstrated the importance of career-relevant learning experiences. Not only did Simon enter the engineering field because of pre-university engineering activities, but he persisted through his degree because of current extracurricular engineering experiences (Stevens et al., 2008). Although it is important to consider factors that encourage students to enter engineering, it is also important to study students' choice in staying in the program. Being part of engineering-related experiences outside of courses, such as team competitions, organizations, and internships, can also influence a student's choice in staying in engineering, through the continuous shaping of their outcome expectations and self-efficacy.

Extracurricular learning experiences and outcome expectancies: Outcome expectancies will differ between students who take engineering-related extracurricular activities and those who have decided not to. One student in O'Connor, Perhamus, Seward and Stevens's (2006) study thought engineering was individualistic based on her core engineering courses, as her classmates were competitive and rarely helped each other out. However, after taking an elective graduate engineering course, she found engineering to be more collaborative and supportive. It is thus possible that after experiencing core theory courses, students might be more likely to hold less communal expectations of engineering, but after taking elective courses that focus on sustainability and ethical responsibility (as an example), they may switch to having higher communal expectations. To add, when studying biomedical interests in undergraduate students, Brown et al., (2015) found that having students' read about a biomedical program that promoted teamwork and collaboration increased students' motivation to pursue biomedical science, as they now believed the field to be more communal. Similarly to pre-university experiences, extracurricular experiences promote a more realistic version of engineering. As engineering is largely based on collaboration and solving societal problems, communal values are more apparent in these extracurricular experiences, compared to lecture-based courses (Carberry & Baker, 2018). Therefore:

> *H3: Students who participate in extracurricular engineering experiences during university will have higher communal outcome expectations compared to students who do not.*

Extracurricular learning experiences and self-efficacy: Self-efficacy will also differ between students who take engineering extracurriculars and those who do not. Active learning is more likely to positively influence one's self-efficacy, academic performance, and positive attitudes about a course than simply learning by lecture (Carberry & Baker, 2018; Freeman et al, 2014; Vogt, 2008). Andrews, Patrick, & Borrego (2021) noticed a decrease in self-efficacy during the first two years of engineering, while there was no difference for students in their last two years. The difference between these students might be explained due to older engineering students having more access to hands-on experience, course projects, and internships (Andrews et al., 2021). Raelin et al., (2015) found that engineering students who took part in their universities co-op program or who participated in internships were more likely to have higher levels of self-efficacy concerning their engineering skills and work ability, compared to students who did not partake in any work terms or internships. Additionally, participating in extracurricular activities, such as in leadership roles, student organizations, and apprenticeships, among other activities, led to students having more confidence in their ability to find a good job after their education was over (Kanar & Bouckenooghe, 2021). As extracurricular learning experiences appear to have some influence on students' perceptions and attitudes, I hypothesize:

> *H4: Students who participate in extracurricular engineering experiences during university will have higher self-efficacy levels compared to students with who do not.*

The indirect relationship – career-relevant learning experiences and intention to persist: As outcome expectancies and self-efficacy is predicted to influence goals (through interest) by Lent et al. (1994), the same relationship is assumed here. However, this relationship is influenced by career-relevant learning experiences, both prior to university and during one's university degree. Raelin et al. (2015) found that internships and co-ops were beneficial in the retention of engineering students. I further suggest that participating in (or having participated in) student organizations, activities, and competitions, or partaking in any engineering-related experience, will likely improve the retention of students as well. Specifically, students who participate in career-relevant learning experiences will have higher communal goal expectations of the engineering field, which will lead to a higher intention in persisting in engineering. Similarly, students who partake in career-relevant learning experiences will have higher self-efficacy, which will lead to a higher intention in persisting in engineering. Therefore, I hypothesize:

> *H5: Career-relevant learning experiences will indirectly influence intention to persist in engineering, through communal outcome expectancies and self-efficacy.*

The moderated relationship – outcome expectancies and intention to persist: Referring back to Expectancy theory, what is positive for one student may not be positive for another. Therefore, the relationship between outcome expectancies and intention to persist is moderated by one's personal preference. As students form beliefs about careers as they grow up, they also form personal preferences (Riegle-Crumb, Peng, & Buontempo, 2019). Individuals develop preferences for desired results attained from their day-to-day life and career. Diekman, Brown, Johnston, and Clark (2010) referred to these preferences as "perceived goal affordances" (p.1053), which consider how much a person believes the career will fulfill certain goals. Diekman et al. (2010) categorized these perceived goal affordances into two categories: agentic and communal. Agentic goals are those related to power and achievement, whereas communal goals are those related to relationships and altruism (Diekman et al., 2010). Careers in STEM fields are perceived to impede communal goals (Boucher, Fuesting, Diekman, & Murphy, 2017; Diekman et al., 2010), meaning that a person would not be able to satisfy altruistic aspirations if they decided to pursue a career in STEM. Therefore, if a communal-oriented individual expected the engineering field to only fulfill agentic goals, such as money, success, and recognition, they would probably not see these outcomes as overtly positive. However, perceptions of a field are malleable which is why experiences and activities can be important in shaping students' interest in a career. As previously mentioned, career-relevant learning experiences can help promote a more communal image of engineering. Diekman et al.'s (2011) study showed that by introducing the communal aspect of teamwork in a scientific job to students with communal preferences, the students' interest towards the field significantly increased. Therefore:

H6: Students' personal goal preference will moderate the relationship between communal outcome expectancies and intent to persist in engineering, such that students *who believe the engineering will fulfill communal goal will only be interested in persisting in engineering if they value communal goals.*

Gender and communal goal preference: Studies have shown that women are more likely to seek communal goals over men, leading to women being less interested in STEM fields, as these fields are not perceived as able to achieve communal goals (McGuire & Leaper, 2016; Dasgupta & Stout, 2014, Diekman et al., 2010). This is not to say that agentic goals are not important to women entering engineering. Rather, research has shown that both men and women similarly value achievement and status outcomes (Diekman et al., 2011; Tellhed, Bäckström, & Björklund, 2018). However, it stands that women are more likely to prefer communal goals, which deters them from choosing fields that are perceived as solely agentic.

H7: Women will be more likely to have higher communal values than men

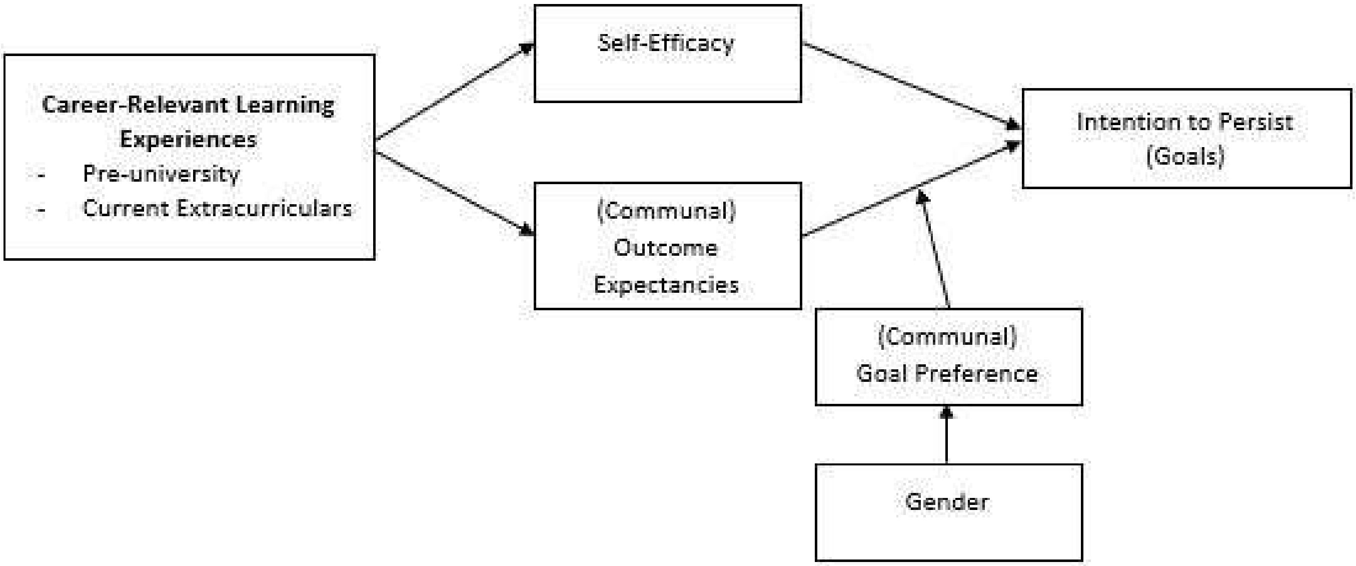
Figure 1 summarizes the hypothesizes in a conceptual framework.

Method

To achieve the objectives of this research study, a survey was sent to all engineering undergraduate students at Concordia University in Montreal, Canada. Previous studies based on SCCT used a similar method, employing a quantitative approach to test their hypotheses (Marra, Rodgers, Shen, & Bogue, 2009; Concannon & Barrow, 2009; Lent et al., 2007; Lent et al., 2005; Lent & Brown, 2003). Measures used in these studies have proven to be valid and have resulted in significant findings.

An online survey was sent to 6189 students via their school platform, Moodle. The survey was completely voluntary, and responses were confidential. Those who completed the

Figure 1: Conceptual Framework



survey were entered in a draw to win a prize. All identifying information for the draw selection was only seen by the primary investigator and then removed from the data. A total of 239 responses were collected. Forty-five responses were removed for being incomplete, leaving a sample of 194 engineering undergraduate students.

The main part of the survey was composed of eight closed-ended questions and one open-ended question, which asked students if being an engineering student at university changed their ideas about the engineering field. The following section describes each measure in detail.

Measures

Pre-university learning experiences: Bohnert, Fredricks, & Randall (2010) identified four types of categories to study extracurricular activities: (1) breadth – the number of different activities, (2) frequency – the time spent in each activity per time frame, (3) duration – the dedication to an activity over a long period of time, and (4) engagement – the degree of active participation. In this study, I was interested in looking at the breadth and duration of pre-university learning experiences. I was not only curious about the number of different engineering activities students have experienced, but also how long they partook in said activity. Participants were asked about the extent to which they have experienced pre-university engineering-related activities over a period of time. This measure was split into two questions. The first question inquired about experiences that occur usually on a yearly or bi-yearly basis. This question had 6 items, including "took part of a STEM summer camp" and "went on school field trips to science museums", among others. Students were asked to indicate how often they experienced each activity and were able to select from the following: 0 – *never,* 1 – *rarely / about twice in all of pre-university schooling,* 2 – *occasionally / about four times in all of pre-university schooling,* 3 – *about half the time / about six times in all of pre-university schooling,* 4 – *most of the time /*

about eight times in all of pre-university schooling, 5 – *almost always / every year of pre-university schooling.* The second question was centered on experiences that occur on a daily, weekly, or monthly basis. There were 9 items to respond to, such as "took part of a STEM club at school" and "read scientific and/or engineering books/magazines". Again, students were asked to indicate how often they experienced each activity and were able to select from the following: 0 – *never,* 1 – *very rarely / less than once per year,* 2 – *rarely / several times per year,* 3 – *sometimes / on a monthly basis,* 4 – *often / on a weekly basis,* 5 – *very often / on a daily basis.* The average of all 15 individual items was calculated to obtain a final number that could be used in analyses. Therefore, it was possible that students who experienced several short-lived activities (responding with 1s and/or 2s to several items) and students who experienced one long-lasting activity (responding with 4s and/or 5s to one or few items) received the same score. This was done intentionally as both type of students experienced similar amounts of experience.

Extracurricular engineering experience: This study was curious about whether students were part of extracurriculars or not. Extracurriculars were split into two categories: (1) internships and co-operative education work terms (co-ops), and (2) student group affiliations and competitions. Students were asked to indicate how many internships and work terms they had completed and were also asked to check every student group affiliation or competition they had been involved in. Internships, co-ops, and competitions do not necessarily happen every year, nor does every student have to take part in them. Moreover, as I am surveying all undergraduate students, some students will have only a year of time in these extracurriculars, whereas other students may have had four or more. Therefore, to get a general idea of whether these extracurriculars have any influence on students' self-efficacy, outcome expectancies, and intent to persist in engineering, I coded students as either 0 – *having no extracurricular experience* or 1 – *having extracurricular experience.*

Engineering self-efficacy*:* Self-efficacy measures how students perceive the extent of their own engineering skills. I measure self-efficacy based on Mamaril's (2014) General Engineering Self-Efficacy Scale for College students. Students were asked how they feel about their engineering skills. The scale has six items and was modified to be measured on a scale of 1 – *strongly disagree* to 5 – *strongly agree*, instead of 1 – *completely uncertain* to 6 – *completely certain*. Internal consistency for this measure was found to be reliable (Cronbach's α = 0.86.

Career outcome expectations**:** Inspired by Verdin et al. (2018), the variable career outcome expectations measures likelihood of achieving certain goals within a career in engineering. Students were asked to indicate their agreement as to whether each goal can be accomplished by having a career in engineering. Diekman et al.'s (2010) list of agentic and communal goals was used in this question. Diekman et al.'s (2010) Goal-Endorsement Factors list is comprised of 23 factors (14 agentic & 9 communal – See Table A1 in Appendix). The items were measured on a scale of 1 – *strongly disagree* to 5 – *extremely agree.* Agentic outcome expectations was internally consistent at α = 0.85, as was communal outcome expectations at α = 0.821.

Intent**:** This variable looks at how likely a student is to pursue a career in engineering. Students were asked about their intentions of completing their degree and working within the engineering field after they graduate. This 4-item scale was adapted from Mamaril's (2014) study. Responses ranged from 1 – *strongly disagree* to 7 – *strongly agree.* Intent was internally consistent at α = 0.88.

Personal goal-endorsement: As in the career outcome expectations measure, the same list of variables was used to measure students' personal goal-endorsements. Using Diekman et al.'s (2010) 14 agentic goals and 9 communal goals, students were asked to think about their future career and to rank the importance of each goal they would want fulfilled. The scale ranged from 1 – *not at all important* to 5 – *extremely important*. Agentic personal goal-endorsement and communal personal goal-endorsement were both internally consistent (α = 0.86, α = 0.85, respectively).

Gender: Gender was measured through a simple multiple-choice question. Students were able to choose from male, female, non-binary/third gender or other or choose not to answer.

Stage in engineering degree: To distinguish students in their first term (hereafter "new" students) from students who have completed at least one term with at least one engineering course (hereafter "advanced" students) respondents were asked to write the number of engineering courses they had already completed. Students who wrote "0" were categorized as new students. Students who completed at least 1 course or more were categorized as advanced students. It was apparent that a couple of students wrote down the number of credits completed rather than the number of courses. To rectify this error, the primary investigator wrote down a corrected version of the number of courses, based on the university's engineering courses and schedule. A second researcher was asked to do the same and a final version of the number of courses was obtained by combining the two. Independent rankings were generally consistent, with only few discrepancies, which were resolved by discussion.

Results

Participants

Students came from varying engineering disciplines: Mechanical (25.26%), Software (16.49%), Computer (13.92%), Industrial (10.31%), Civil (10.31%), Electrical (8.76%), and Other (14.95%; Other could include environmental engineering, aerospace engineering, etc.). Ninety-four percent of students were taking their studies full-time and only 22% were international students. To add, 45.36% of the sample identified as White or Caucasian, 22.17% as Asian or Pacific Islander, 3.61% as Biracial or Multiracial, 3.09% as Black or African Canadian, 3.09% as Hispanic or Latino and 1.03% as Indigenous. 15.46% did not identify as any of the categories listed and 6.19% opted to not list their ethnicity. Age ranged from 18 to 39, with an average of 21.4. Finally, 35.05% of respondents identified as women, 62.37% as men, and 1.03% as non-binary or third gender. The percentage of women in this sample is higher than the 19.32% of women enrolled at Concordia University in engineering (1196 female students out of 6189 total students). One respondent identified as a gender not listed and two opted to not respond. It is also important to know that 66 respondents (34%) had just started their engineering degree. Out of the remaining 128 students, the number of courses completed ranged from 1 to 49, with an average of 19.16 courses completed. A typical degree is about 40 courses for engineers at this university. Those who took more likely had to take pre-requisites and/or took extra courses.

Students generally had high levels of self-efficacy, with an average of 4.03 on a scale of 5, with 5 being the most confident about one’s ability to succeed in engineering-related courses and assignments. Students also had high intentions of staying in engineering. A large portion of students (80.27%) strongly agreed that they planned on completing all their requirements to obtain their engineering degree, but this percentage dropped to 53.36% when asked if they intend to pursue a career in the engineering field. In the following analyses, the variable *intent to persist in engineering* considers both these items, as well as two others. However, it is important to note that not all students who strongly believe they will graduate as an engineer also believe they will have a career in engineering. A breakdown of students' responses can be found in the Appendix – Figure A1. To continue, most advanced students had not participated in any internships or co-ops nor in any student group or competition (Appendix – Figures A2 & A3). When it comes to pre-university engineering experiences, it appears that going on school field trips to museums and taking part of a science fair were the most frequent in the yearly activities, whereas going to a STEM summer camp was the least. Watching scientific and/or engineering shows was also quite popular, followed by discussions of engineers with family and friends for daily activities. Being part of a community STEM group and visiting on-site engineering facilities came in last. A summary of responses can be found in the Appendix – Tables A2 and A3

Overview

Results are reported by hypothesis. Tables 1-3 present means, standard deviations, and correlations for all variables tested within this study. Tests of Hypotheses 1 and 2 were done via analyses for the full sample (N = 194) and then for the subgroup of new students only (N = 66). For Hypotheses 3 and 4, I only analyzed the responses of advanced students (N = 128). These hypotheses included the variable of extracurricular activities, which new students have not yet had the time to experience. Including new students in this part of the analysis would skew the results; therefore, they were removed. Hypothesis 5 was tested on the full sample , as well as in separate analyses for advanced students only. Hypothesis 6 and 7 were tested with the full sample.

Table 1: Pearson Correlations - All Students

	MEAN	SD	Personal Agentic Goals	Personal Communal Goals	Agentic Expectations	Communal Expectations	Self-Efficacy	Intent to Persist	Pre-University Experience	Extra-Curriculars
Personal Agentic Goals	3.64	0.61	-							
Personal Communal Goals	3.73	0.68	0.57***	-						
Agentic Expectations	4.01	0.54	0.38***	0.37***	-					
Communal Expectations	3.89	0.67	0.42***	0.56***	0.58***	-				
Self-Efficacy	4.03	0.69	0.32***	0.16*	0.21**	0.17**	-			
Intent to Persist	6.11	1.30	0.13*	0.07	0.26***	0.11	0.21**	-		
Pre-University Experience	1.64	0.89	0.26***	0.27***	0.14	0.18**	0.13*	0.11	-	
Extra-Curriculars	0.49	0.50	0.02	0.03	-0.07	-0.06	0.11	0.07	0.13*	-

*Notes: n ranges from 193-194. The range of scores for personal agentic goals, personal communal goals, agentic expectations, communal expectations, and self-efficacy range was from 1 to 5; the range for intent to persist was 0 to 5 and for pre-university experience was from 1 to 7. Extra-curriculars was nominal with 0 being no experience and 1 being with experience. * 0.05 < p < 0.10 (marginal significance); ** p < 0.05; *** p < 0.001*

Table 2: Pearson Correlations - New Students

	MEANS	SD	Personal Agentic Goals	Personal Communal Goals	Agentic Expectations	Communal Expectations	Self-Efficacy	Intent to Persist	Pre-University Experience	Extra-Curriculars
Personal Agentic Goals	3.77	0.62	-							
Personal Communal Goals	3.84	0.67	0.57***	-						
Agentic Expectations	3.97	0.52	0.64***	0.59***	-					
Communal Expectations	3.96	0.60	0.59***	0.64***	0.68***	-				
Self-Efficacy	4.14	0.65	0.48***	0.13	0.29**	0.41***	-			
Intent to Persist	6.08	1.25	0.13	0.11	0.34**	0.20	0.22*	-		
Pre-University Experience	1.77	0.98	0.43***	0.37**	0.30**	0.37**	0.32**	0.18	-	

Notes: $n = 66$. *The range of scores for personal agentic goals, personal communal goals, agentic expectations, communal expectations, and self-efficacy range was from 1 to 5; the range for intent to persist was 0 to 5 and for pre-university experience was from 1 to 7.* $* 0.05 < p < 0.10$ *(marginal significance);* $** p < 0.05$; $*** p < 0.001$

Table 3: Pearson Correlations - Advanced Students

	MEAN	**SD**	**Personal Agentic Goals**	**Personal Communal Goals**	**Agentic Expectations**	**Communal Expectations**	**Self-Efficacy**	**Intent to Persist**	**Pre-University Experience**	**Extra-Curriculars**
Personal Agentic Goals	3.57	0.59	-							
Personal Communal Goals	3,68	0.67	0.56***	-						
Agentic Expectations	4.03	0.55	0.26**	0.27**	-					
Communal Expectations	3.85	0.70	0.34***	0.52***	0.54***	-				
Self-Efficacy	3.97	0.71	0.23**	0.10	0.19**	0.07	-			
Intent to Persist	6.12	1.33	0.13	0.06	0.22**	0.07	0.21**	-		
Pre-University Experience	1.56	0.83	0.12	0.20**	0.06	0.07	0.02	0.07	-	
Extra-Curriculars	0.57	0.50	0.11	0.08	-0.16*	-0.11	0.20**	0.07	0.14	-

*Notes: n ranges from 127-128. The range of scores for personal agentic goals, personal communal goals, agentic expectations, communal expectations, and self-efficacy range was from 1 to 5; the range for intent to persist was 0 to 5 and for pre-university experience was from 1 to 7. Extra-curriculars was nominal with 0 being no experience and 1 being with experience. * 0.05 < p < 0.10 (marginal significance); ** p < 0.05; *** p < 0.001*

However, for Hypothesis 7, I excluded the 5 respondents that were neither female nor male. Results are followed by the reporting of supplementary analyses.

Tests of Hypotheses

Two linear regressions were conducted to determine if communal expectations and self-efficacy were predicted by pre-university engineering experiences. As shown in table 4, pre-university experience was a statistically significant predictor of communal expectations ($F(192) = 6.24$, $\beta = 0.14$, $p = 0.01$, $R^2 = 0.03$) and a marginally significant predictor of self-efficacy ($F(192)= 3.49$, $\beta = 0.10$, $p = 0.07$, $R^2 = 0.02$). Pearson correlations indicate a positive relationship between pre-university engineering experiences and communal expectations ($r = 0.18$, $p = 0.01$) and self-efficacy ($r = 0.13$, $p = 0.07$). This analysis was then replicated, but only analyzing the 66 new students. As there is a possibility that advanced students have had their self-efficacy, engineering expectations, and intent to persist in engineering influenced by other factors within university, mitigating the effect from pre-university engineering experiences, I decided to remove advanced students from this part of the analysis, to further test the hypothesis that pre-university engineering experiences influence communal expectations and self-efficacy. Results show a positive correlation between these variables within new students ($r = 0.37$, $p = 0.00$; $r = 0.32$, $p = 0.01$, respectively). Moreover, linear regressions indicate that pre-university engineering experiences was a statistically significant predictor for both dependent variables, such that these experiences predicted communal expectations ($F(65) = 10.28$, $\beta = 0.23$, $p = 0.00$, $R^2 = 0.14$) and self-efficacy ($F(65) = 7.15$, $\beta = 0.21$, $p = 0.01$, $R^2 = 0.10$), as shown in Table 5. Hypotheses 1 and 2 are supported.

Table 4: Regression tests for All Students

Predictor	**β**	***t***
Dependent variable: Communal Expectations		
Pre-University Experiences	0.14	2.50**
R^2	0.03	
F	6.24	
df	192	
Dependent variable: Self-Efficacy		
Pre-University Experiences	0.10	1.86*
R^2	0.02	
F	3.49	
df	192	

Notes: * $0.05 < p < 0.10$ *(marginal significance);* ** $p < 0.05$; *** $p < 0.001$

Table 5: Regression tests for New Students

Predictor	**β**	***t***
Dependent variable: Communal Expectations		
Pre-University Experiences	0.23	3.21**
R^2	0.14	
F	10.28	
df	65	
Dependent variable: Self-Efficacy		
Pre-University Experiences	0.21	2.67**
R^2	0.10	
F	7.15	
df	65	

*Notes: * 0.05 < p < 0.10 (marginal significance); ** p < 0.05; *** p < 0.001*

Next, two t-tests were performed to check for a relationship between extracurriculars and communal expectations, and extracurriculars and self-efficacy. T-tests were both one-tailed, as it was believed that students with extracurricular experience would have higher communal expectations and higher self-efficacy. As reported in Table 6, the t-test showed no significant difference for communal expectations, $t(125) = 1.28$, p = 0.90, not supporting hypothesis 3. On the other hand, a significant difference was found between extracurriculars and self-efficacy, $t(126) = -2.23$, p = 0.01, such that students partaking in extracurriculars ($M = 4.09$, $SD = 0.66$) had higher levels of self-efficacy than students with no extracurriculars ($M = 3.81$, $SD = 0.75$). Thus, Hypothesis 4 is supported.

Table 6: Means, Standard Deviations, and Independent T-Tests of Extracurricular Differences

	Personal Agentic Goals	**Personal Communal Goals**	**Agentic Expectations**	**Communal Expectations**	**Self-Efficacy**	**Intent to Persist**
Students NOT partaking in Extracurricular						
Mean	3.49	3.62	4.13	3.94	3.81	6.01
SD	0.59	0.71	3.95	0.70	0.75	1.50
Students partaking in Extracurriculars						
Mean	3.63	3.72	3.95	3.78	4.09	6.20
SD	0.58	0.64	0.54	0.71	0.66	1.19
Independent Samples T-Test	-1.25	-0.87	1.85	1.28	-2.23**	-0.81

*Notes: n ranges 125-126. The range of scores for personal agentic goals, personal communal goals, agentic expectations, communal expectations, and self-efficacy range was from 1 to 5; the range for intent to persist was 0 to 5. * 0.05 < p < 0.10 (marginal significance); ** p < 0.05; *** p < 0.001*

Hypothesis 5 posited an indirect effect between career-relevant learning experiences and intention to persist through expectations and self-efficacy. First, I examined whether these career-relevant engineering experiences, both pre- and during-university, had any direct influence on intent to persist in engineering. Linear regressions were conducted between pre-university experiences and intent to persist for all students, as shown in Table 7. This predictor did not account for any significant variance in the outcomes ($F(192) = 2.17$, $\beta = 0.16$, $p = 0.14$, $R^2 = 0.01$). Similarly, extracurriculars was not a significant predictor of intent to persist (current students only; $F(127) = 0.66$, $\beta = 0.19$, $p = 0.42$, $R^2 = 0.00$). Linear regressions were also conducted between self-efficacy and intent to persist, as well as between communal expectations and intent to persist. Self-efficacy was found to be predictive of intent to persist, ($F(193) = 8.97$, $\beta = 0.40$, $p = 0.00$, $R^2 = 0.05$), while communal expectations was not ($F(192) = 2.20$, $\beta = 0.207$, $p = 0.14$, $R^2 = 0.01$). Next, as reported in Table 8, a mediation analysis was conducted to determine if there were any indirect effects between pre-university engineering experiences and intent to persist through self-efficacy and communal outcome expectations. The results show no confirmation that pre-university engineering experiences predict intent to persist in engineering ($\beta = 0.09$, $z = 0.89$, $p = 0.37$). Breaking down the analysis, there was no significant indirect effect of pre-university engineering experiences on intent to persist via self-efficacy ($\beta = 0.03$, $z = 1.43$, $p = 0.15$) nor was there any significant effect of pre-university engineering experiences on intent to persist through communal outcome expectations ($\beta = -0.02$, $z = -0.94$, $p = 0.35$). Table 9 displays another mediation analysis, which was done involving only advanced students to study the effect of extracurricular engineering experience on intent to persist. Similarly, no direct effect was found between extracurriculars and intent to persist ($\beta = 0.20$, $z = 0.83$, $p = 0.40$). Furthermore, no significant indirect effects were found between extracurriculars and intent to persist via self-efficacy ($\beta = 0.08$, $z = 1.39$, $p = 0.16$) or via communal expectations ($\beta = 0.02$, $z = 0.53$, $p = 0.60$). Based on these tests, no indirect or mediating effect can be confirmed between career-relevant engineering experiences and intent to persist in engineering through communal expectations or self-efficacy, not supporting hypothesis 5.

Table 7: Linear Regressions involving Intent to Persist, Career-Relevant Learning Experiences, Outcome Expectations, and Self-Efficacy

Predictor	**β**	***t***
Dependent variable: Intent to Persist		
Pre-University Experiences	0.16	1.42
R^2	0.01	
F	2.17	
df	192	
Dependent variable: Intent to Persist		
Extracurricular Experiences (advanced	0.19	0.81
students)	0.01	
R^2	0.66	
F	127	
df		
Dependent variable: Intent to Persist		
Communal Expectations	0.21	1.48
R^2	0.01	
F	2.20	
df	192	
Dependent variable: Intent to Persist		
Self-Efficacy	0.40	3.00**
R^2	0.05	
F	8.97	
df	193	
Dependent variable: Intent to Persist		
Agentic Expectations	0.62	3.73***
R^2	0.07	
F	13.89	
df	192	

*Notes: * $0.05 < p < 0.10$ (marginal significance); ** $p < 0.05$; *** $p < 0.001$*

Table 8: Indirect Effects (EI) of Pre-University Engineering Experience on Intent to Persist

	Estimate	**95% CI**
Main effect on Intent to Persist	0.09	[-0.11, 0.29]
IE on Intent to Persist via Self-Efficacy	0.03	[-0.01, 0.07]
IE on Intent to Persist via Communal Expectations	-0.02	[-0.07, 0.02]
IE on Intent to Persist via Agentic Expectations	0.06*	[-0.01, 0.12]

Notes: * $0.05 < p < 0.10$ *(marginal significance);* ** $p < 0.05$; *** $p < 0.001$

Table 9: Indirect Effects (EI) of Extracurricular Engineering Experience on Intent to Persist

	Estimate	**95% CI**
Main effect on Intent to Persist	0.20	[-0.27, 0.66]
IE on Intent to Persist via Self-Efficacy	0.08	[-0.03, 0.20]
IE on Intent to Persist via Communal Expectations	0.02	[-0.05, 0.08]
IE on Intent to Persist via Agentic Expectations	-0.10	[-0.24, 0.04]

*Notes: * 0.05 < p < 0.10 (marginal significance); ** p < 0.05; *** p < 0.001*

Next, to determine if goal preferences moderated the relation between career expectations and intent to persist, two linear regressions were performed with an interaction variable. First, a linear regression was performed between communal expectations, communal goal preferences, and intent to persist. The null model, which only included communal expectations and communal goal preferences as independent variables, did not account for significant variance in the intent to persist ($F(192) = 1.11$, $p = 0.33$, $R^2 = 0.01$). The model remained non-significant when adding the interaction variable ($F(192) = 0.75$, $p = 0.53$, $R^2 = 0.01$; R^2 change = 0.00), dismissing the hypothesis of a moderation effect. Thus, hypothesis 6 is not supported.

Lastly, Hypothesis 7 tests the relationship between gender and communal goals. Previous studies have noticed that women tend to have higher communal goals than men (Diekman et al., 2011; Diekman et al., 2017). This usually leads to women choosing career fields that are known to be communal, such as nursing and education, and avoid those that are not perceived as communal, such as engineering and computer science (Koppel, Cano, & Heyman, 2002; Diekman et al., 2010; Hirsh et al., 2011). A one-tailed t-test was performed and the relationship was found to be non-significant ($t(187) =1.25$, $p = 0.11$). In other words, women ($M = 3.80$, $SD = 0.67$) and men ($M = 3.68$, $SD = 0.67$) appeared to have similar communal goal preferences. Results can be seen in Table 10. Hypothesis 7 is not supported.

Supplementary Analyses

Supplementary analyses were performed for agentic variables and gender differences. It was interesting to note that agentic expectations and communal expectations were positively correlated ($r = 0.58$, $p < 0.001$), as were personal agentic goals and personal communal goals ($r = 0.57$, $p < 0.001$). Personal agentic goals was also positively correlated with self-efficacy ($r = 0.32$, $p < 0.001$).

Table 10: Means, Standard Deviations, and Independent T-tests of Gender Differences

		Personal Agentic Goals	**Personal Communal Goals**	**Agentic Expectations**	**Communal Expectations**	**Self-Efficacy**	**Intent to Persist**	**Pre-University Experience**	**Extra-Curriculars**
Women	***Mean***	3.50	3.80	3.98	3.93	3.75	5.99	1.41	0.50
	SD	0.52	0.67	0.54	0.70	0.66	1.26	0.70	0.50
Men	***Mean***	3.72	3.68	4.04	3.87	4.18	6.18	1.73	0.48
	SD	0.63	0.67	0.53	0.65	0.66	1.33	0.93	0.50
Independent Samples T-Test		-2.58**†	1.25	-0.68	0.65	-4.22***	-0.94	-2.70**†	0.27

Notes: n ranges from 67-68 for women and is 128 for men. The range of scores for personal agentic goals, personal communal goals, agentic expectations, communal expectations, and self-efficacy range was from 1 to 5; the range for intent to persist was 0 to 5 and for pre-university experience was from 1 to 7. Extra-curriculars was nominal with 0 being no experience and 1 being with experience. One-tailed t-tests were performed for personal agentic goals and self-efficacy, in favor of men. One-tailed t-tests were performed for personal communal goals, in favor of women. And two-tailed t-tests were performed for agentic expectations, communal expectations, intent to persist, pre-university experience, and extracurriculars. 0.05 < p < 0.10 (marginal significance); ** p < 0.05; *** p < 0.001*

†Welsh test, Levene's test was significant

Next, I performed similar analyses on agentic variables as I did for the communal variables, in order to determine if agentic variables had any larger influences on students than communal variables did. I repeated the analyses conducted in hypothesis 5 (mediation analysis) and hypothesis 6 (moderation analysis). First, a linear regression was conducted between agentic expectations and intent to persist in engineering. Results show that agentic expectations is predictive of intent to persist (F(192) = 13.89, $\beta = 0.62$, $p < 0.001$, $R^2 = 0.07$), unlike communal expectations. However, no indirect effect was found between pre-university engineering experiences and intent to persist through agentic expectations ($\beta = 0.06$, $z = 1.68$, $p = 0.09$), nor was there any indirect effect found between extracurricular engineering experiences and intent to persist through agentic expectations ($\beta = -0.10$, $z = -1.44$, $p = 0.15$). Next, a linear regression was performed between agentic expectations, agentic goal preferences, and intent to persist, in attempt to find support for a moderator. The null model, which only included agentic expectations and agentic goal preferences as independent variables predicting intent to persist, was significant ($F(192) = 7.01$, $p = 0.00$, $R^2 = 0.07$) and remained significant when adding the interaction variable ($F(192) = 4.87$, $p = 0.00$, $R^2 = 0.07$; R^2 change = 0.00). However, the interaction variable did not add anything to the relationship as observed from the change in R^2 , therefore we cannot assume that there is a moderation effect. The significance is likely due to agentic expectations predicting intent to persist, regardless of goal preference.

Additional analyses were performed for any possible gender differences. A t-test was conducted between pre-university engineering experiences and gender. Levene's test proved to be significant ($F(1) = 4.42$, $p = 0.04$), thus the Welsh's t-test was performed. Results were significant, suggesting that men ($M = 1.73$, $SD = 0.93$) are more likely to have more pre-university engineering experience than women ($M = 1.41$, $SD = 0.70$), $t(168.69) = -2.70$, p =

0.01. No differences were found between gender and extracurricular experience ($\chi^2 = 0.07$, $p = 0.789$), such that 34 women and 58 men took part in extracurriculars, while 34 women and 63 men did not. Finally, men were found to have higher personal agentic goals (*M* = 3.70, *SD* = 0.63) than women (*M* = 3.50, *SD* = 0.52), *t*(187) = -2.439, $p = 0.01$. Men were also found to have higher self-efficacy levels (*M* = 4.17, *SD* = 0.66) than women (*M* = 3.75, *SD* = 0.66), *t*(187) = -4.22, $p < 0.001$.

Discussion

The purpose of this study was to determine if taking part in career-relevant learning experiences, both prior to and during university, would influence students' perceptions of engineering, including their expectations of the field and whether they believed they could succeed, and ultimately, their choice of remaining within the field. This next section will discuss the results of the study and integrate some direct quotes written by participants about their perceptions of engineering in university.

A major point in this study is the importance of communal goals in engineering. Today's perception of engineering remains very much stereotypical, being that engineering is only for *men*, requires an innate skill, focuses on mechanical problems, and is a solo profession. Rarely is engineering perceived as altruistic, a field that relies on teamwork and works to benefit society and help others. Some participants in this study were subject to these stereotypes before being exposed to the true side of engineering:

> **"My thoughts on engineering were that they were people working on heavy machinery and that were good with maths and sciences. I did not necessarily want to work with heavy machinery, but I liked the idea of creating and developing new**

> **ideas, so I joined engineering. I told myself I would figure out a way to skip working with the heavy machinery if ever it was the only way to use my degree after graduation and it turns out I didn't have to work with heavy machinery and that my preconception of engineering was based on how they are portrayed in the media."** – F26, Industrial Engineering
>
> **"I learned that engineering is more than just fixing cars or working on airplanes, engineers are needed in domains not normally associated with engineering [like] pharmaceuticals."** – F23, Mechanical Engineering

Now, while past studies have shown that women are likely to have higher communal values than men (Diekman et al., 2011; Diekman et al., 2017), exposing the communal side of engineering is not only to attract more women. Engineering needs to be better portrayed as a field that can satisfy communal goals, in order to attract individuals who value such goals as cooperation and collectivity (Koppel et al., 2002; Boucher et al., 2017). If engineering is able to change the way it is currently perceived, it will be able to attract a variety of individuals who value communal goals, including men, non-binary, and third-gender individuals (Boucher et al., 2017).

One method of changing these stereotypical perceptions is through career-relevant learning experiences. Belanger, Diekman and Steinberg (2017) noticed that students with past STEM experiences were more likely to believe engineering could satisfy communal goals. Hypothesis 1 suggested that having pre-university engineering experiences would be predictive of having communal expectations of the field. Being exposed to STEM communal experiences has not only been linked to higher interest in the field, but also higher positive attitudes, (Belanger et al., 2017). Similar to previous studies (Belanger et al., 2017; Aschbacher et al., 2010), the results of this study show that students with more pre-university engineering experiences were more likely to have higher communal expectations of the field, supporting Hypothesis 1. In other words, having been exposed to engineering, either through activities at school, such as STEM field trips or projects, or at-home activities, such as engineering discussions with family or reading STEM magazines, allowed students to learn about the communal side of engineering. Many of these engineering activities attempt to demonstrate how engineering can be beneficial to individuals and the community. Colvin et al. (2013) made sure that after every engineering activity, communal values were discussed with the students. These activities and discussions created a positive change in the perception of engineering, as students became more aware of how engineering benefits society (Colvin et al., 2013). Other studies have similarly found that exposing students to the "real-side" of engineering has led to positive changes in their perception of the field (Genareo et al., 2018; Meija et al., 2015).

Moving forward, as pre-university engineering experiences have shown to be important for students' perceptions of engineering, similarly, these experiences have also shown to be of importance for students' self-efficacy. Hypothesis 2 indicated that having pre-university engineering experiences would lead to having higher levels of self-efficacy. Results show support for this hypothesis, indicating, indeed, that students who had more pre-university engineering experience were more likely to have higher levels of self-efficacy. While there is the possibility of reverse causation, such that students with higher levels of self-efficacy are more likely to choose to participate in these engineering experiences, previous studies have shown in pre- and post interviews and surveys, that these experiences make students more confident in their skills (Meija et al., 2015; Ozogul et al., 2019). Pre-university engineering experiences allow students to receive the support and resources they need to advance their engineering knowledge and expertise. Not being exposed to engineering experiences can lead to believing in stereotypes created and reinforced by society and media (Cheryan et al., 2015; Carberry & Baker, 2018). These stereotypical beliefs have been found to be negatively related to students' levels of self-efficacy (Luo, So, Wan, & Li, 2021). So, when students are properly introduced to engineering, i.e., through a course or program, their levels of self-efficacy tend to improve. Therefore, participating in STEM activities can positively influence students' belief in their ability to succeed in engineering. It is important to note that in most engineering interventions done in research (Meija et al., 2015; Newley et al., 2017; Falco & Summers, 2019; Hughes & Roberts, 2019; Ozogul et al., 2019) the sample of students participating is generally gender-balanced or is only composed of girls. Unfortunately, this is not always the case, as girls are usually part of a minority when participating in STEM activities. Being only one of a few girls can significantly decrease one's confidence in oneself and create a feeling of discomfort (Dasgupta, Scirce, & Hunsigner, 2015), especially if the environment is not inclusive and stereotypes are reinforced (Boston & Cimpian, 2018). In this case, taking part in a STEM intervention to increase one's self-efficacy may backfire. For this reason, when conducting pre-university engineering experiences, those in charge must ensure that all students are receiving proper attention and support to make them feel included.

Next, the influence of extracurricular engineering experiences, such as internships, competitions, and student affiliations on students was also studied. To start with, no relationship was found between extracurriculars and communal expectations, providing no support for Hypothesis 3. It is likely that students are taught certain communal values of engineering in their core classes, which is why we do not see a significant difference in the perceptions of students partaking in extracurriculars and the perceptions of those who are not. As engineering programs across Canada must teach students the ethics and responsibility of being an engineer to adhere to the accreditation requirements, many universities now incorporate lessons or courses about the impact of technology and engineering on society within their curriculum (Lloyd & Schmitt, 2014). For example, Concordia University requires students to take ENGR 201, *Professional Practice and Responsibility*, ENGR 202, *Sustainable Development and Environmental Stewardship,* and ENGR 392, *Impact of Technology on Society*, core courses about the responsibility of engineers towards the healthy and safety of society and the environment. These courses lead to students understanding how engineering can fulfill communal goals. In fact, one student mentioned how her courses have taught her some of these communal values:

> **"The engineering classes that I have taken, especially ENGR 201 and ENGR 202, have taught me about the responsibilities and values [and respect] that a good engineer should have, in order to benefit society the most. Professional engineers should abide by a strict code of ethics to prioritize the welfare and safety of society."**
> – F20, Software Engineering

To add, many students wrote about how university has positively changed their views of engineering and society, regardless of participating in extracurriculars or not. The following quotes from students, one who is active with the Society of Automotive Engineering and one who has opted out of any extracurricular activities, describe their changed perception of their field, as they continue to learn more about it:

> **"Before starting university, I wanted to go into engineering because I knew it had good career opportunities and because I'd always enjoyed building things and understanding how they work. After starting university I've realized that while these things are true, there is much more to it and I've started to truly understand what being an engineer means. Engineering has a lot to do with management and**

> **business, it also has a lot to do with communication and working together and being imaginative."** – M21, Mechanical Engineering
>
> **"I have now a better understanding to what engineering truly means and how it can differ between disciplines. I also learned that nothing can be achieved without the will of collaboration as great ideas are made using the minds of different people with different perspectives on the world."** – M21, Industrial Engineering

Therefore, while it may be that university courses are mostly theory based and skill-focused (Carberry & Baker, 2018; Lachney & Nieusma, 2015), some courses continue to promote this sense of community and altruism.

To continue, I studied the relationship between extracurricular experience and self-efficacy, hypothesizing that students' participating in extracurriculars would have higher levels of self-efficacy than those who did not. Hypothesis 4 was supported; Students who took part in internships or who participated in student engineering groups (or both) were more likely to have higher levels of self-efficacy than students who took part in neither. This is likely to do with the hands-on work they do and the real-life situations they experience. Learning only by lecture has been shown to lead to low self-efficacy levels (Carberry & Baker, 2018). These next two students shared their thoughts on needing more than just their core courses to keep them motivated throughout their education:

> **"The exposure to actual engineers and tech talks was essential to give me more hope and create a kind of curiosity toward real life problems and what to focus on."** – M20, Computer Engineering

> **“[I] didn’t expect to lose motivation regarding physics and math courses, but I did since the ENGR courses were very boring …The MIAE courses helped me continue my path into engineering since they were more related to real-life cases and were more interesting.”** – M19, Mechanical Engineering

Students enjoy the actual “doing” of engineering and working alongside other people, which is what these internships and student groups allow them to do. Previous studies support this finding. Hanna et al. (2021) noticed an increase in self-efficacy after first-generation STEM students (students who were the first in their family to go to college) took a two-week internship program, working alongside professors and conducting STEM research. Additionally, Andrews, Borrego, and Boklage (2021) noticed that students who used “makerspaces”, workspaces that held resources and tools to help students with design projects, had significant increases in their self-efficacy levels. In general, extracurriculars appear to have significant importance in the lives of engineering students, as they provide engaging and realistic experiences of the field. A mechanical engineering student wrote about his experience with extracurriculars:

> **“[…] During the search for my work terms, I felt very underqualified for the jobs that I was applying for. Although many of the jobs had requisites that weren't mandatory, they were asking for experience in coding or manufacturing or CAD software, and I felt really unqualified. That's why I decided to join the Concrete Toboggan team. I have done more hands-on work in the last 2 months than I had my entire degree […] We analyzed parts, did sketches, used tools in the labs, and I was actually using the material I had learned in class and actually applying it somewhere. Now with that and more experience to put under my belt, I feel confident searching for my next work term […]”** – M21, Mechanical Engineering

Our results also showed that men were likely to have more pre-university engineering experiences than women did. However, once they entered university, men and women were equally likely to join internships and/or student affiliations and competitions.

To continue, previous studies have found that participating in engineering programs and activities led to higher levels of interest in engineering (Belanger et al., 2017, Byars-Winston et al., 2010). Hypothesis 5 looks at the indirect relationship between career-relevant learning experiences and intent to persist in engineering, through communal expectations and self-efficacy. No relationship was found between these variables, providing no support for Hypothesis 5. Based on these results, it seems that having any prior engineering experience or extracurricular experience does not influence one's intent in staying in the engineering field. Yet, self-efficacy and agentic expectations of the field did appear to predict intent to persist in engineering. These conflicting results could be an issue of power, as mentioned in the results section. Consistent with SCCT, students' self-efficacy and career expectations, specifically agentic expectations, predicted their intent to persist in their field (Lent et al., 1994). In other words, students are more likely to want to continue in engineering if they believe they have the skill and ability to succeed and if they expect engineering to fulfill agentic-type goals, such as achievement, success, and power. And based on previous results, career-relevant engineering experiences had some influence on self-efficacy and career expectations. So, while we cannot assume any indirect relationship between career-relevant experiences and intent to persist in engineering, it would be best to further investigate this relation.

This study also intended to introduce Expectancy Theory into SCCT. In SCCT, outcome expectancy is said to predict goals/intent to persist in said career. If positive outcomes can be expected to be achieved through a career, an individual is more likely to be interested and pursue that career. However, based on Expectancy Theory, in order for an individual to be motivated, they must also have valence, a desire for the expected outcome (Vroom, 1964). Desires for certain outcomes depends on the person and what they value. A moderator was introduced for Hypothesis 6, suggesting that personal goal endorsements would influence the relationship between outcome expectations and intent to persist. In other words, students who value communal goals would likely be interested in a career that would allow for the fulfilment of these goals – and students who value agentic goals would want a career that satisfies agentic goals. I found no support for this hypothesis. First and foremost, communal expectations did not predict intent to persist in engineering. Meaning, regardless of whether students expected engineering to fulfill communal goals or not, their expectations did not affect their intention to persist in engineering. This relationship did not change when accounting for their preferences of communal goals. Secondly, while agentic expectations did predict intent to persist in engineering, students' personal agentic preferences had no extra influence on the relationship. Thus, if engineering is perceived to be able to satisfy agentic goals, students will likely want to continue working in the field, regardless of their own personal goals. Moreover, the relationship found between agentic expectations and intent to persist in engineering adds to the uncertain literature surrounding outcome expectancy and goals within SCCT. Many studies have found only a relationship between outcome expectancies and interest, but not between outcome expectancies and goals/intent to persist (Lent et al., 2003; Lent et al., 2005; Lent et al., 2008). I further urge researchers to distinguish what type of expectations they are measuring and if they are deemed positive for all who are involved.

Results also reinforce prior research studying the gender gap of self-efficacy between women and men in STEM (Inda et al., 2013; Marshman et al., 2018; Whitcomb et al., 2019;

Stewart et al., 2020). In this study, we see that men have significantly higher levels of self-efficacy compared to women. This gender gap of self-efficacy is likely due to societal and cultural stereotypes surrounding gender and STEM achievement (Marshman et al., 2018; Luo et al., 2021). To add, Vermeer, Boekaerts, and Seegers (2000) noted that girls and boys assessed their achievements and competence differently than one another, with girls tending to be harsher on themselves. It’s also possible that women hold themselves to higher standards than men, which reduces their confidence levels, even though they achieve the similar grades (Marshman et al., 2018). As career-relevant learning experiences have proven to increase self-efficacy, it is important that we give women the opportunity for these experiences, in order to increase their self-efficacy levels. Another difference found between women and men were their agentic goal endorsements. Men had significantly higher agentic goal endorsements than women, valuing success, recognition, financial rewards, and other achievement-type goals. Other studies found no difference between genders (Diekman et al., 2010) or simply a small difference (Diekman et al., 2011). The difference between studies is possibly due to the difference in sample, as this study’s sample was strictly composed of engineering students, while Diekman et al.’s (2001, 2011) sample comprised of psychology students. To continue, this study did not find any gender differences between communal goal endorsement, providing no support for Hypothesis 7. This result goes against previous findings in other studies (Diekman et al., 2011), likely due to this study’s sample containing only engineering students. Therefore, the women who entered engineering perhaps do not have as high of a communal preference than women who choose other fields. As results show that women were less likely than men to have had any pre-university engineering experiences, we can assume that a majority of women from other fields also did not have much pre-university engineering experiences. In other words, throughout elementary and high school, girls are less likely to participate in engineering or STEM experiences, which does not allow them to learn the communal aspects of the fields. Therefore, girls who were more communal goal-oriented probably did not find engineering interesting or able to meet their needs, which is why we do not see them in our sample and there is no gender difference for communal goal endorsement.

As a last point, the difference between what is learned before and during university was not a main point of research in this study, however Lakin et al. (2020) suggest a possible mismatch between what is taught during pre-university engineering activities and what is taught during university may contribute to students' negative attitudes and disinterest. Through the analysis of these results, it was noticed that the effects of pre-university engineering experience was reduced when including advanced students in the analysis. This finding from Hypothesis 1 and 2 suggests that there are other factors that influence students' expectations and self-efficacy besides their pre-university experience. So, while we cannot confirm or deny Lakin et al.'s (2020) hypothesis, it seems that it would be appropriate to investigate further.

On a final note, it is clear from the results that career-relevant learning experiences are important to getting students involved and interested in engineering. These experiences not only provide a better understanding of engineering, demonstrating the real-life impact engineers have on society, but also provide students with the support and resources they need to believe in themselves and succeed.

Limitations and Future Research

The first limitation of this study involves the sample of students who participated in the research. The sample was quite small considering the number of students who are registered in engineering at the university. The sample was then also reduced when analyzing only new students, resulting in 66 students being analyzed at one point in time. A larger sample would lead to more power to detect effects and reduce the margin of error. To add, the sample was only obtained from one Canadian University, which diminishes the generalizability of results. Other studies may want to obtain a sample from a different university or a different country. It would also be of interest to study specific sub-disciplines of engineering. As STEM fields differ from one another, so do the sub-disciplines of engineering, where each speciality has its own culture and norms. Research on sub-disciplines of engineering is fairly new, with only a few studies having been conducted (Kelley & Bryan, 2018; Sweeney, 2020).

Next, the measure for pre-university engineering experiences could have been more specific. As I focused on encompassing both breadth and duration of these experiences to capture the larger picture of students experiencing STEM activities prior to university, I likely missed out on interesting findings that could have been directly or indirectly linked to intention to persist in engineering. Moreover, as this variable looked at past experiences, participants might not have been accurate with their responses, due to memory errors. Future research might want to conduct a longitudinal research, studying students' interests in STEM and their participation in career-relevant learning experiences from a young age up until university. Other studies may want to do a qualitative research, where researchers can explore and understand the importance that career-relevant learning experiences have on students' interest and intent of pursuing engineering.

Conducting a longitudinal study would also be more accurate in establishing causation. This study was able to identify many correlations between variables and only assumes causation based on previous literature. It is possible that students with high levels of self-efficacy and those who have communal expectations of engineering choose to participate in career-relevant learning experiences more than those who have low levels of self-efficacy and who do not have high communal expectations of the field. There is also the possibility of reciprocal causation between the dependent and independent variables, such that both variables have some influence on one another. To add, there might be other factors at play that were not accounted for in this study, such as feelings of belongingness, family pressure, financial status, etc.

I also suggest continuing to explore the relation between Expectancy theory and SCCT. Knowing that individuals are more likely to do something when they value the outcomes that will come out of it, it is likely that that logic could be used when studying career choice in STEM. As this study's sample was quite small, there likely was an issue of power for the analysis. Future research may want to replicate this analysis with a larger sample. Additionally, while this study measured communal and agentic goals, it might be of interest to use other items for that measure. For example, one might want to look at intrinsic and extrinsic outcomes, as these outcomes will also differ in value depending on the person (Konopaske, Ivancevich, Matteson, 2018).

Implications

Engineering organizations and companies, as well as educators, would likely benefit from investing in career-relevant learning experiences for students. Whether it be at the university level, offering internships or partnering with student organizations, or at the pre-university level, investing in STEM camps or offering student field trips, investing in these experiences is investing in the next generation of engineers. By supporting and improving these career-relevant learning experiences, students will learn about the realistic work engineers do and how vast the field actually is.

At a young age students should gain a proper understanding of what being an engineer involves. Many of the misconceptions stem from improper information transmission from teacher to student at the elementary and high school level (Hammack, 2016; Kilty & Burrows, 2019). These misconceptions are then reinforced through the stereotypes displayed in the media and pop culture (Cheryan et al., 2015; Carberry & Baker, 2018), and deters students who feel like they would not fit in. However, by introducing both the communal and agentic side of engineering, students will gain a more appropriate representation of what the field is like. With more accurate information about engineering, students will be able to make a better-informed decision of whether to pursue engineering or not.

Engineering firms may also want to re-evaluate their internships and work terms for university students. Students appear to most value the hands-on work they experience during these internships. Some internships fall short of providing these experiences, only offering students administrative work instead of actual engineering tasks. To keep students interested, it would be wise to offer some level of hands-on experience. Additionally, engineering organizations may want to support and work with student engineering groups, providing them with opportunities to experience real-life engineering work or to have a discussion with current licensed engineers. Moreover, universities may want to require all engineering students to take part in internships or co-ops and not only have it as an option. Seeing and working in the field allows students to obtain a more accurate image of what life as an engineer would be and gives them the opportunity to apply what is learnt in class to the actual world.

Creating these experiences for students and supporting them along their educational journey will improve their self-efficacy and perceptions of the field. It’s no secret that people have been asking for more diversity within the engineering workforce. Promoting the communal side of engineering, especially prior to university, will increase the number of community-oriented students interested in entering the engineering field. As women are likely to have more communal goals, promoting this side of engineering will likely see an increase in the number of women interested as well. Diversity has proven to be beneficial to organizations and individuals, leading to financial gains, enhancing creativity and innovation, increasing satisfaction and well-being levels among employees, and improving communication (Dwertmann, et al., 2016; Kadam et al., 2020; Morais Maceira, 2017; Fine et al., 2020; Shannon et al., 2019). For these reasons, engineering organizations and partners should attempt to do more to better attract and support women and other underrepresented groups. By increasing diversity within engineering, society will be better served as everyone becomes represented (Puri, 2017).

Conclusion

Career-relevant learning experiences are important in the education and career choices of students in engineering. Many students value hands-on experiences and learning about real world situations. These experiences provide a more accurate representation of the field and support students in improving their skill, knowledge, and confidence. This study showed that pre-university engineering experience is positively related to students' self-efficacy and communal expectations of the field. And while extracurricular activities in university, such as internships and student groups, may not influence communal expectations, they did have a positive relation with students' self-efficacy. Both types of experiences, pre- and during university, did not appear to have any influence on students' intent to persist in engineering. However, it was found that having higher levels of self-efficacy and agentic expectations did predict their intent to continue in the field. Moreover, stereotypes surrounding engineering and who is fit to be an engineering is still prevalent in society. Learning and experiencing what the field actually is and what engineers actually do, helps mitigate those stereotypes. As we try to encourage more girls into STEM, specifically in engineering, career-relevant learning experiences, both prior and during university, are an important factor to consider in making a difference.

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Appendix

Table A1: Diekman et al.'s (2010) Goal-Endorsement Factors

Agentic Goals	Communal Goals
Achievement	Attending to others
Competition	Caring for others
Financial rewards	Connection with others
Focus on self	Helping others
Demonstrating skill	Intimacy
Independence	Serving the community
Individualism	Serving humanity
Mastery	Spiritual rewards
Power	Working with people
Recognition	
Self-direction	
Self-promotion	
Status	
Success	

<u>Figure A1: Intent to Persist in Engineering</u>

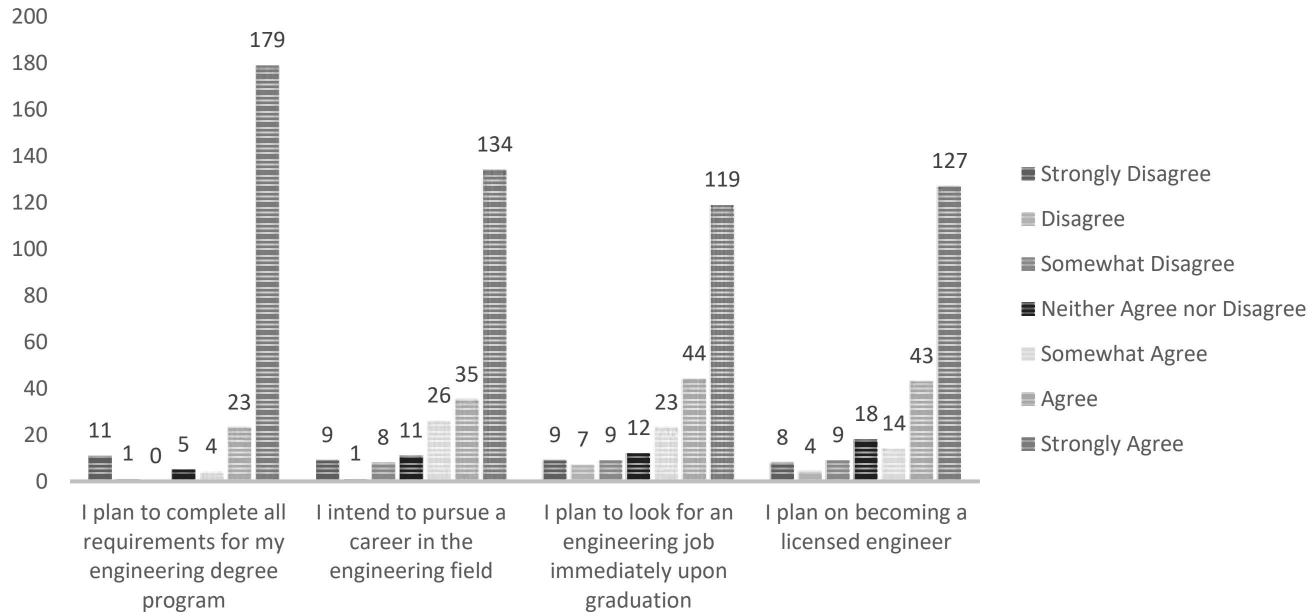

Figure A2: Participation in Internships/Co-ops

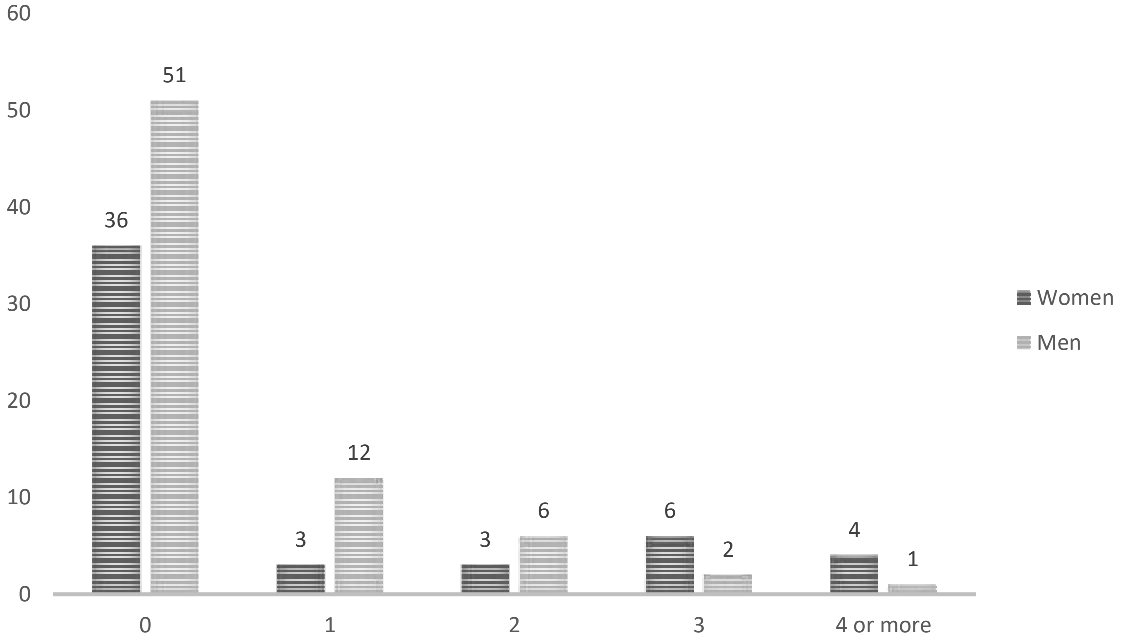

Figure A3: Participation in Student Groups/Competitions

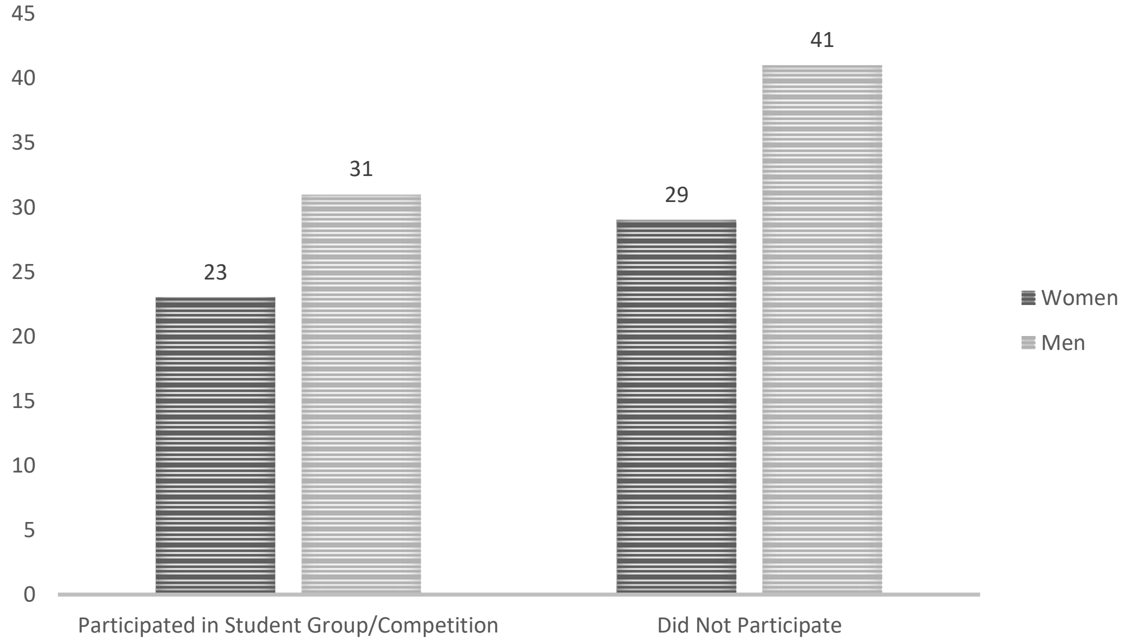

Table A 2: Number of Students with Pre-University Engineering Experiences (Yearly)

	0 – Never	**1 – Rarely / about twice in all of pre-university schooling**	**2 Occasionally / about four times in all of pre-university school**	**3 – About half the time / about six times in all of pre-university schooling**	**4 – Most of the time / about eight times in all of pre-university schooling**	**5 – Almost always / every year of pre-university schooling**	**MEAN**	**SD**
Went on school field trips to science museums	27	54	40	33	18	23	**16.15**	**1.55**
Visited on-site engineering facilities with the school	92	57	21	14	2	9	**14.99**	**1.30**
Had engineers come to your school and present to your class	99	46	31	9	6	4	**14.92**	**1.20**
Took part of a science fair	41	62	41	19	10	22	**15.80**	**1.56**
Attended a STEM conference or event outside of school	79	59	25	13	10	9	**15.19**	**1.40**
Took part of a STEM (science, technology, engineering, and/or mathematics) summer camp	143	26	11	5	3	7	**14.56**	**1.19**

Table A3: Number of Students with Pre-University Engineering Experiences (Daily)

	0 – Never	**1- Very rarely / less than once per year**	**2 – Rarely / several times per year**	**3 – Sometimes / on a monthly basis**	**4 – Often / on a weekly basis**	**5 – Very often / on a daily basis**	**MEAN**	**SD**
Received engineering/computer science lessons during a required science course	36	48	27	39	25	20	**16.15**	**1.61**
Took part of an engineering/computer science/robotics club at school	96	37	18	12	22	10	**15.27**	**1.61**
Took part of a community STEM (science, technology, engineering, mathematics) group	115	37	17	7	11	8	**14.90**	**1.41**
Visited science museums with family/friends	46	74	42	23	6	4	**15.39**	**1.17**
Visited on-site engineering facilities with family/friends	102	45	29	12	3	4	**14.88**	**1.17**
Discussed engineering with your family/friends	22	18	36	44	45	30	**16.83**	**1.54**
Read scientific and/or engineering books/magazines	29	33	28	58	31	16	**16.39**	**1.51**
Watched scientific and/or engineering shows (Bill Nye, How it's Made, etc.)	23	14	19	53	39	47	**17.09**	**1.61**
Interacted with at-home STEM activities (lab kits, k'nex, robots, etc.)	54	28	41	31	15	26	**16.02**	**1.71**