



## Development of Employability Skills in Engineering Disciplines through Co-op

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## **1. Introduction**

This study aims to understand the varying levels of the development of skills vital to the success of a cooperative experience, per each engineering discipline. In particular, it asks: “what skills have students developed during their academic career before they enter a work environment?” In particular, this study focuses on co-op programs and work experience during a student’s education. Co-op has evolved over the years, changing and adapting according to students, as is discussed by Haddara and Skanes [1]. This means that there are various forms around the world. Due to the location of this study (i.e. Toronto, Canada), we looked at the Canadian Association for Co-operative Education (CAFCE), as they discuss what contributes to a successful co-op program in today’s age. They outline a pre-training for students that would foster transference of skills into the workplace so that they may develop and gain “relevant employability skills... before graduation.” In this case, employability skills are skills employers look for in potential hires that can serve as a metric for evaluating performance [2].

Due to the broadness of the term “employability skills” there is no definitive list of which employability skills students are to gain, or what skills are to be transferred. This makes skill development difficult to track. There is, however, an expectation for co-op students to perform according to a standard. Competency lists exist for engineering bodies and curriculums (such as CEAB and ABET) that schools adhere to. This gives program directors a focal point to develop curriculums around and a list of skills can then emerge. Even with these lists and the above manual, few universal methods exist to measure the development of these competencies in relation to a co-op experience.

This study aims to bridge this gap by using a skills-based model to assess skill development prior to co-op. This model can be used as a “check-list” for co-op assessment and is used in this study to understand the discrepancy between disciplines in the skills that are developed in the years prior to entering a work environment. This model is adapted from models reported by Jiang, Lee & Golab [3], Jackson & Chapman [4], Rainsbury, Hodges, Burchell & Lay [5], Spencer & Spencer [5], Coll, Zegwaard & Hodges [6], Jackson [7].

### **1.1 Background**

At the beginning of this project, a literature review was conducted to understand what sorts of skills are considered employability skills. Immediately, it was clear that very little research has been done comparing the skills of different engineering disciplines. Shyamalee, Wickramasinghe and Dissanayake wrote about the varying skills expected from mechanical engineering and electrical engineering graduates from the employer’s perspective [8]. Here, they outlined skills such as communication and knowledge of standards for electrical

engineering graduates, while technical skills and knowledge based on basic principles were considered important for mechanical engineering workers. There were skills that overlapped (such as knowledge of standards). Their research shows the differences between disciplines from an employer's perspective. Our research, on the other hand, takes a student-focused approach with this, by aiming to better understand students and their experiences. This is to better understand workplace and school contexts.

D. Jackson and E. Chapman (2011) highlighted the non-technical skills gap in business graduates from the students' perspective [4]. Their paper is very important because it lists and describes skill development. Using similar principles, this work is focused on engineering students. Using comparison, we are trying to show how educational environments have impacted skill development.

Rainsbury, Hodges and Burchell's (2002) study well highlights the importance of various workplace competencies, from student and graduate level perspectives [5]. Like this study, our project is getting a variety of perspectives, but the variance derives from the different disciplines being interviewed. This detailed demographic allows more context to then analyze. The above mentioned study does not specify the discipline of study for these students, which is a gap our project aims to fill.

Finally, this project is closely related to the graduate attributes outlined by the various engineering accreditation bodies (ie CEAB and ABET) [9]. There are various attributes listed there is very little in the way of measuring skills associated with these attributes. Looking at the

## 1.2 Co-op at the institute of research

In this work-in-progress, we focused on engineering students from a large Canadian university. At this school, the year is divided into 3 semesters, each 12 weeks long (not including final exams) beginning in September: a fall semester (Sept-Dec), a winter semester (Jan-Apr) and a summer semester (May-Aug). The summer semester is further divided into 2 terms, each 6 weeks long. Within this structure, the co-op program is typically divided into 2 terms, taking place after a student's second and third year. After their second year, students will complete their first co-op term during the summer semester (ie for 4 months). In the following fall semester, students will return for their third year. Students will then complete their final co-op term starting in the summer term for 8-16 months. In the following fall semester, students return to complete their fourth year in school. There is a level of flexibility for students in that second term, as they may start in that summer, fall or winter semester. In total, students can get 12-20 months of work experience.

Due to this division, students get a chance to work in different companies and industries. The school's co-op program offers its students a "portal" filled with diverse job opportunities that students can apply for. Students also have the option to register any job

they obtained external to the portal, so long as it complies with the employer requirements. Each student enrolled in the program must complete both resume and cover letter writing seminars before applying. During the co-op terms, students must complete 2 courses, one during their first term of co-op experience and the other in the last 4 months of their final term. Students also must write a report at the end of each term. The courses are centered around reflection and portfolio management, while the term paper is a description of their job and is reflective in nature. Similar to other schools, there is a fee associated with both of these courses for access to the portal, much like other co-op programs.

Students also choose to do internships outside of the co-op program. Although these internships are within their field of study, they are not registered with the coop program. There are various logistical and personal reasons for this decision and are not fully discussed in this paper. It is also important to note the young nature of this co-op program, as it is approximately 6 years old. This means that participation is still rapidly growing and new industry partnerships are being formed every year. This is important to discuss, as the participants in this study are not limited to students officially enrolled in co-op programs.

## 2. Method

Our research approach is qualitative, allowing us to deeply understand students' experiences and connect them to their contexts. This allowed us to explore themes as they emerged and make meaning out of individual stories. Qualitative research does not seek to extrapolate universal truths.

From the literature, the most prevalent skills and models were adapted for this scope of this study. The model can be seen in A.1. A full description of how the model was created is discussed below. Once the model was developed, the respective undergraduate program directors of the Mechanical Engineering, Civil Engineering and Electrical Engineering & Computer Science (EECS; this faculty includes Software Engineering, Electrical Engineering and Computer Engineering) departments were contacted. We had a conversation with each of the directors and discussed which skills they found their program focused on, and what these skills looked like. The faculty members were also shown the model and asked to discuss how their curriculum deals with these skills. The feedback from the faculty conversations was used to validate and update the model.

Next, the faculty meetings and model were used to guide the focus group questions. A total of 3 focus groups were conducted, 1 for each program being analyzed. Between 3-5 people participated in each group. To get the depth of employability skills, students who had participated in the co-op program were mixed with students who had done an unofficial internship. The cut off was that the field of work had to directly relate to their discipline (ie. no general or part time positions were considered like retail, food industry, etc). Prior to the interview, students were asked about their experience and the researcher made the final decision.

During the interview, the students were asked questions about their experience of certain employability skills at work, and then they derived certain skills back to school and co-op. Then, students were presented the comments made by the faculty members and were asked to comment further. This was to understand to what degree students agreed. Because of how focus groups are designed, this flow was casually followed, to promote open conversation and to ensure various views were captured.

## 2.1 Model development

The point of the model was to provide a layout for the design of this study. When identifying the skills that may be lacking, we first needed to establish what to look for. Once the baseline was established, we could begin the process of understanding shortcomings through interviews and analysis. This model not only selected the skills, but also gave very specific descriptions of the scope of these skills, as they relate to this study. Once this model was created, we formed adequate questions for student engagement; this also created a strong frame for analysis.

To understand which skills would be most applicable to a co-op experience, a systematic literature review was done. The keywords used to select the papers were a combination of: “skills”, “co-op”, “employability” and “engineering”. Various databases were used. Each paper was read and then major skills were highlighted [3-7], [9-19]. These were then categorized and counted using NVivo. The results are seen below in figure 1. Some of these papers were evaluating the co-op experience as a whole and then extracting certain skills, while other papers would be concerned with specific skills and how students experienced them in their education. Figure 2 below shows the frequency of mention of each skill. The most common skills were: *teamwork*, *critical thinking*, *knowledge acquisition*, *communication*, *initiative*, and *problem solving*.

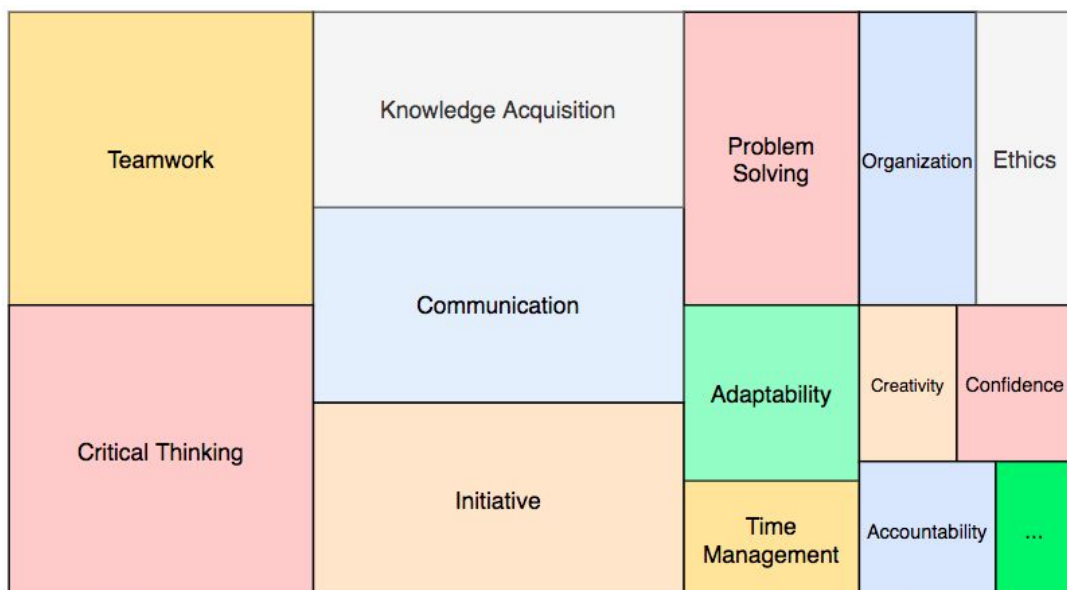


Figure 1: NVivo image showing the most frequently mentioned skills in literature

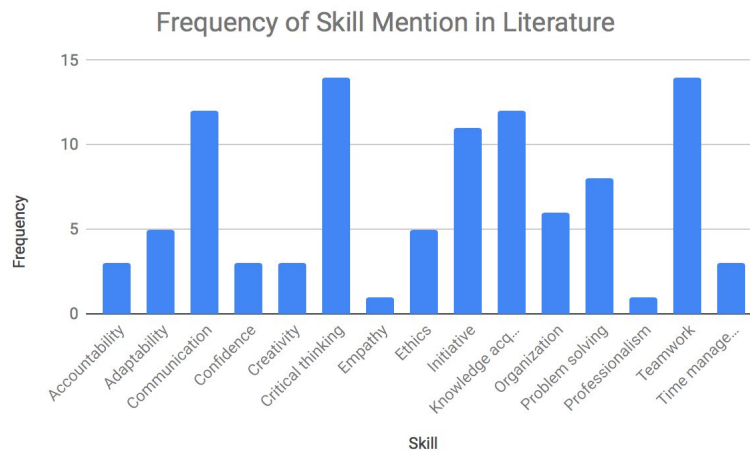


Figure 2: Chart showing number of papers describing each skill

Once these skills were selected, the next step was to find a set of features that encompass each skill. Terms such as *communication* and *time management* are quite abstract and as such, need a definition. Although many papers have defined how these skills look in engineering practise, the aim was to synthesize this extensive body of work into one usable and applicable model. This model used the behavioural descriptions reported in various literature to define these skills. In some papers, these behaviours were pre-categorized; in other cases, a list was given and categories were assigned according to descriptions and patterns. In the end, the model helps define these ambiguous skills and determines the scope of each.

## 2.2 Validating the Model

To ensure that the model is optimized for this study, the descriptions that were most frequently recorded or were found in studies to be rated the highest were the only ones selected. Furthermore, these descriptions were compared against papers that were focused on certain skills. The model was updated based on conversations with professors, faculty members, and students outside of the institute of this study. This is because the model is meant to be transcendent of location and context.

Furthermore, certain exclusions to the data gathering and literature review were made:

- This project is focused on comparing programs; therefore, the individual experience is not as important as the group experience. This means that we excluded components of these skills that relate to the self (efficacy, comfort, confidence, etc.)
- We are using the community-centered framework, which means student motivation is not a major part of this study. It is accepted as part of the questioning and for contextualizing, but does not drive the analysis or the results.
- All final decisions were made by the research team, regarding what was included and what was excluded from the final study. This introduces an inevitable element of bias.

## 2.3 Methodology and framework

The methodology chosen for this project is ethnography. The larger aim was to not to prove or disprove a theory, but rather to understand a phenomena [20]. Furthermore, the framework for this study is community-centered learning. The idea is to understand how a culture fosters employability skills as opposed to how students individually learn. In focus groups, students were asked to connect their experiences to the larger narrative of their discipline or workplace and each focus group was analyzed as a collective. Also, the study aims to understand the culture surrounding skill development and what leads to student behaviour. It is important to understand that this project is particular to the region of study and does not aim to make sweeping statements to be translated outside of the context of this school. Instead, this study aims to describe the fact that there are nuances with skill development in each discipline and how the larger institute may interact with this.

In the analysis phase, focus was put on identifying the nature of various “communities of learning”, as discussed by Svinicki when describing community-centered frameworks [21]. How students described their workplaces was compared to how they described their school terms. Also, different disciplines were asked to discuss which skills they found their specific program gave more or less focus to, to understand the underlying theme of the program.

## 3. Results

### 3.1 Mechanical engineering focus group

This focus group consisted of 5 upper year students. 3 participants had completed the co-op program through the school and the other 2 did internships external to the school. Only one student applied and got their position through the co-op portal, while the other students using their personal connections. The reasons for not participating are not explored in this group. Regarding work fields, multiple students mentioned the heavy focus on research and data analysis during their work term. There was also a big amount of time students spent on designing and building, after the initial research phase.

The top skills that students found they had been very prepared for when entering the workforce were: critical thinking, in particular design, problem solving and teamwork. Students, inversely, mentioned being very unprepared for the expected level of initiative. Another major skill mentioned was communication; students found that they had difficulty communicating with different people in different management roles. Also, they found it difficult to translate their technical jargon into common terms. Similarly, knowledge acquisition was something students noticed a lack of focus towards. They felt that they had an adequate base level of knowledge but little confidence in it. This is because their courses cast a large net in context and were unable to fully specialize in much. Students barely mentioned personal or social ethics, neither in school nor in the workforce. Organization was a skill that

was not linked to a particular context but students agreed it to be a skill they had utilized frequently.

All of the students described their work environment as independent-focused. One student mentioned “guidance from [their] supervisor” throughout the placement, while the other student focused on their learning from doing. It seems from the conversations that many of the students had more formal relationships with their supervisor, mirroring managers more than mentors. This did adapt and become more casual, while maintaining professionalism. This is rather different from the environment they described in school. One student described the professors as having “open door policies”, which allowed for more opportunities for general conversation. This was mentioned as a factor for why the students may have found communicating through email and other formal means a transition. Another challenge these students faced was interdisciplinary communication. The act of simplifying communication into understandable and non-technical terms was considered a hurdle for the students in this focus group.

There was quite a focus on project management in this group. Students were divided on whether the school had focused too much on design and not enough on project management. Students who had worked in more design-heavy positions believed that they had been adequately prepared, while other students found that “that side of project management... the school could use a little more of us learning about that, because I don’t feel that we learned enough”. From this divide, it is interesting to see the intersection of community influences on skill importance. All of these students took the same courses, but their work environment very much changed how they developed their thinking. The students who worked in larger teams, with more relations with other workers had to learn to think as a group. This meant taking more interest in project management. Students who were more design focused found their knowledge base adequate. In the end, the students did agree that they were equipped with enough basics.

Regarding communication, students agreed that they did have a good basic level of written communication. It was interesting that one student did mention that mechanical engineering students were inferior to “civil engineering students”, in particular. This specific comparison shines a light into culture differences between the 2 disciplines. It seems that to these students, the civil engineering curriculum focuses on technical communication the most. Similarly, students mentioned a level of curiosity in EECS courses that was missing in mechanical courses. This connects to a previous comment regarding the level of teamwork these students mentioned doing. This indicates that there may be less independent curiosity embedded into this culture.

### 3.2 Civil engineering focus group

This focus group had 3 participants, 2 of whom did co-op participated in the co-op program and one who did an external internship. Only one of these positions was procured



using the portal. All of the students are upper year students in civil engineering. The stated reason for not participating in the program was administrative in nature, where the student did not find it applicable to register their employment position. The job placements in this group were very diverse, ranging from consulting to field work to academic research. Through the variety, the one similarity students described was the intense research and analysis phase of their first few weeks on the job. All of the students also mentioned that their positions were rather independent, with very little mentorship positions.

The most developed skills pointed out by the participants were teamwork, communication, and knowledge acquisition. The major skills listed as underdeveloped are critical thinking and open-ended problem solving. Students did not speak too much about ethics, but did mention the lack of big picture connections that exist in the classroom. Organization was not particularly discussed, but time management and the stressful environment was mentioned in school.

Students focused on design thinking and problem solving quite a lot. They mentioned how little they had developed this skill before entering their workforce: “sometimes you have that knowledge, but you’re not able to use it”, was something one of the student’s mentioned when discussing knowledge application. The students mentioned that they were very used to solving simple problems in classrooms but did not know how to re-apply these concepts outside. This was not a major problem in co-op, as the students were able to adapt, but this frustration was mentioned multiple times. It was interesting the way students described their workplaces in relation to this. All of the students mentioned how much autonomy they had in their work, and that meant solving complex problems with little guidance. In particular, a student mentioned how they had to develop programs based on their research, in a managerial role and had to learn a lot of new skills to do so.

Regarding critical thinking, the students mentioned how they had a lack of understanding for how various disciplines interacted in a big system. One student mentioned how they would like to understand how a plot of land goes from barren to a building and what specific considerations are required. This example best illustrates the gap the students were describing: they lacked the ability to design the details. When entering their workforce, it was these details that they needed to figure out and work with. Another student described it as “think[ing] outside the box and be[ing] able to solve problems”. In their final year, students mentioned that doing capstone did introduce this skill in more depth, but found that it was too late and still lacking nuance.

The workplace described by all of these students is rather similar to their school environment, in that it requires a lot of individual work, but the biggest difference was the autonomy and stress. Students said that the stress of grades for so many years actually compromised their ability to focus on the actual problem and content. In their workplace, being curious and “going down a rabbit hole” (describing how students would go in depth to

understand a particular concept) was enjoyable. This allowed them to produce something “good” and to “learn in a more well-rounded way”. This makes a really important reference to workplace culture. In particular, it highlights how the time-intensive nature of engineering culture actually does harm in skill development and students are thriving in autonomous places. This is most likely not unique to civil engineering students but was mostly discussed by them, more so than other focus groups.

### 3.3 Computer and software engineering (EECS) focus group

This focus group was unique because it was a mixed group. This was done to understand how reflection and communication may be different when the group is more diverse. Two of the participants were EECS students (in computer and software engineering) and one was a Geomatics Engineering student. Of this group, two of the students participated in the official co-op program and one of these positions was obtained through the portal. The reason for not participating was purely logistical, as the student was over the credit limit to be allowed to register in the program. This was not discussed as a problem as much as an explanation. The workplaces discussed were quite different, one being more field based, while the two EECS positions were more office and project oriented.

For EECS, the most developed skills were teamwork, knowledge acquisition and problem solving. Students mentioned the underdevelopment of critical thinking and ethical intelligence. Communication was mentioned as a skill that was mildly developed but there were clear gaps. Organization was mentioned by one of the students, as it pertains to project management.

Design thinking was again mentioned quite a lot in this group. Students felt that they did not have much in the way of critical thinking skills. Many of their school projects and problems were very constrained. This meant that when they were given autonomy, students were less sure of themselves. Students said that they were really good at learning, so were able to manage in the workplace, but the design component was something they had less ease with. When it came to applying their knowledge in the real world context, for example, they had difficulty. This highlights the culture within the program, as being more independent and theory focused. Upon transitioning to a more open-ended environment, they noticed the boundaries that had been placed on them.

With teamwork, students felt that they were very limited in their ability to manage workplace disagreements. One student talked about their experience with a non-communicative manager and the struggle of overcoming this to continue their work. They mentioned feeling “intimidated and not confident” in this position, which meant the disagreements spanned a few weeks. They were able to navigate the situation and learn from it, but expressed the difficulty in getting there. Another student mentioned that school did not provide them much in the way of communication tactics in these cases, as they had, in the past, always just contacted their professor to deal with it. This was playfully called

“whistleblowing” practises, but analyzing it further shows that students did not find the school environment suitable for autonomous team dynamic management. This shows how there is a clear divide in the minds of the participants of how these two cultures vary.

Ethical intelligence was discussed in this group, in particular the execution of it. Students discussed how much accountability they held for their workplace and the extensive training they had to undergo in their transition relating to behaviour and professionalism. This was starkly different than discussion of public health in the school. Participants described ethical discussions as reactive and driven by consequences. Students were not necessarily guided on how not to make ethical mistakes, but just that they should not. This division shows that the students recognized the importance of ethical intelligence in both contexts, but were able to fully understand it in practise when entering the workforce. This speaks to the difference in culture between school and these workplaces. In school, ethics were added as a cautionary necessity, but with little personalization. Students were not shown to explore it, but just told about it. This rigidity defines the way these students describe their specific culture. On the other hand, work was seen to be more strict, but also more individual. Mistakes were each student’s to be made, not told about. This meant students were more responsible for their specific behaviour.

It is important to highlight what combining programs did for the conversation. Students spent more time listening to each other and there was less linearity in the answering of questions. This was more evident anytime a point came up that one student disagreed with. These disagreements led to further exploration and students offered more detail about their experiences. Similarities also emerged in real time. This was interesting because when students agreed on certain skills, they recognized that the details were still different and would spend more time providing context and specific examples. This meant that each participant was more curious and engaged. This is not unique to this group: whenever there was a disagreement in the other focus groups, students would provide more insight. However, the contexts in the other focus groups were quite similar and so, there were just fewer opportunities for differences. Students in the combined group also were more wary of making too many overarching statements. This may be because they did not want to make any assumptions around students with less context. This was different because in the other focus groups, students would reference skills that they may have developed, but rarely discussed how personal vs systematic they may have been.

Some skills were also highlighted for the Geomatics Engineering discipline: organization, knowledge acquisition and ethical intelligence were amongst the most proficient. Communication and problem solving were skills they found to be less developed. For the purpose of this study, the details of these skills will not be discussed.

## 4. Discussion

### 4.1 Faculty interviews

As mentioned above, faculty interviews were conducted at the beginning of the project. For mechanical engineering, the undergraduate program director (UPD) outlined the top 3 skills he found that the faculty focused on developing the most: teamwork, problem solving, communication and critical thinking. It is very interesting that these are the same skills that the students picked out in their focus groups, unprompted. This means that there is a good relationship between what the faculty is attempting to promote and what is being received. The UPD discussed how design was a major focus in the courses and how that means that knowledge acquisition is, although still a high priority, secondary and mostly embedded into the design coursework. The UPD did spend some time discussing the focus on ethical responsibility in various courses. This was different, considering that the students barely discussed it. This indicated that this may be lost in communication. The UPD reiterated that the culture focuses on thinking critically, including ethical responsibility.

From the civil engineering perspective, the UPD was contacted. They highlighted the top skills their program best developed: communication, ethical intelligence and organization, in particular time management. They mentioned that courses barely focused on critical thinking or continuous learning. Students generally agreed with these findings, with the major difference laying in ethical intelligence. From the conversations, students seem to have a lack of context for this in the school environment. This indicates a gap between students and professors, which may be interesting to further explore. Students also mentioned that teamwork was a major skill that had been part of their education, which the UPD did not discuss. This may indicate that professors are unable to assess teamwork skills in a way that would show proficiency. Finally, the UPD mentioned their lack of interaction with the co-op students after returning. This means that the two contexts that these students are shifting between are not very seamless and there is a clear knowledge divide. This is commonality with all of the faculty interviews.

From the EECS perspective, a professor involved with accreditation was contacted. This is because they had good insight into the courses and the culture of the program. They outlined the following top skills: problem solving, teamwork, and knowledge acquisition. They found that critical thinking and communication skills were underdeveloped in the curriculum. The culture described in the school was more independent and oriented around course work. This professor did not spend time discussing the ethical responsibility, which is different from what the students discussed. Otherwise, the skills mentioned are very similar to the ones outlined by the students. This indicates that there is not as much of a divide between student and faculty experiences, however the professor did mention having very little understanding of how students may have changed after returning from a co-op term.

This shows that there is a focus by the professor on curriculum details and less on culture development.

#### 4.2 Comparison across disciplines

Each of the groups mentioned the lack of initiative and how that translated into what they believed to be good work ethic. In each of the focus groups, students said that initiative was a vital skill for their success in the workplace and the community they worked in would highly value it. But within their academic careers, there was very little room for initiative to be taken. This speaks to a general theme within engineering culture of rigidity and intensity. That is not unique to this institute, or said as a critique. This does however change how student's values and expectations shift as they enter the workforce.

Another similarity amongst students was the gap in communication, in particular the balance of technical and general communications. One consistent mention was email etiquette. Students were very unsure about who to email and how to email within a company. This is also how students felt about speaking to members of their company in the managerial capacity. This outlined a structured community for communication in the workforce, unlike the more informal culture within academia.

It was interesting that most, if not all, of the students skipped over organization, not in a way to express a lack of importance, but rather as something very well established. This shows that this is a skill that school has done a great job thoroughly embedding into their culture. This is because students never discussed this as part of their curriculum, but rather as an inevitability as part of their rigorous workload.

Finally, students mentioned how some of the skills they found underdeveloped had to do with their curriculum and others a function of practicality. For example, students understood why practical examples of large set data-bases were difficult to bring into a course. This shows that some gaps are valid and understandable, but others might not be too difficult to deal with.

#### 4.3 Recommendations

From the data obtained, there are some recommendations that can be made. For one, it would prove very useful to discuss skill development with students when creating a co-op course. Many of the interviews discussed the disconnect that the students felt when doing the co-op courses. For some students, these courses felt a lot like "homework" and may not have fulfilled their intended purpose. Students did find the reflective component very helpful, but mentioned recommendations they would personally like to make. This shows that students have a lot of knowledge that they would like to share. By introducing this experiential perspective, co-op programs may be able to become even more effective than they currently are.

Another recommendation is to explore the relationship between curriculum and co-op programs. It is clear that each discipline has its own culture that the faculty are attuned to. They can provide more detailed perspectives on how to improve each individual student's experience. From the interviews done here, the divide is clear and it is a resource that can be tapped for mutual benefit.

Other recommendations require more data. In particular, it might be interesting for co-op programs to explore the idea of adding skill-based training modules. These could be catered to disciplines in particular, to give each student a unique experience. As the combined focus group showed, students learn well from one another. This might be an interesting format to explore for reflection purposes. By increasing multi-disciplinary experiences before entering a workplace, co-op programs may be able to better prepare their students. These recommendations would require further data to be fully developed. A summary of the findings can be found in table 1 below.

Table 1: Reported Underdeveloped Skills, per discipline

	Mechanical Engineering	Civil Engineering	EECS Disciplines
Teamwork			
Critical Thinking		✓	✓
Knowledge Acquisition	✓		
Communication	✓		✓
Initiative	✓	✓	✓
Problem Solving		✓	✓
Organization			
Personal and Social Ethical Intelligence	✓	✓	

## 5 Conclusion

This study aims to highlight the development of employability skills, as they differ across 3 different engineering programs at one institution. These skills were evaluated in a co-op context, by looking at 3 disciplines: Mechanical Engineering, Civil Engineering, and the EECS department. Table 2 above shows the major gaps that exist within the disciplines in this study. In particular, critical thinking and problem solving were reported as limited in the civil and EECS focus groups, while considered a strength in the mechanical group.

Communication was strongest for civil engineers, and rather underdeveloped in the other focus groups. Skills such as teamwork were developed in different ways, depending on the discipline. This means that skills themselves are more complex in different programs and deserve more attention. This shows that, despite a common list of expected employability skills, different disciplines prepare their students with different skills. It is important to note that some skills are commonly missing between disciplines. This may have to do with a discipline's curriculum or the co-op training. The details can be explored by gathering more information. These skills can be tracked to the communities these students are a part of. Co-op programs can use this data to better understand the student experience. By continuing this study and gathering more data, the nuances of the differences may become more clear.

### 5.1 The future of this study

The results in this study provide insight into the differences in various disciplines within engineering, as it relates to employability skills. Generally, all of this data is preliminary. This means that in the future, it is important to gather more data from each of the disciplines that we are studying. It would also be interesting to do more combined focus groups with various disciplines. This way we can get comparative analysis in real time. It also gives a chance for the students involved in the groups to get outside of their discipline bubbles and find out how their discipline is more or less similar than they had assumed. The ideal case, moving forward, would be to have 3 focus groups for each discipline and 3 combined focus groups.

Furthermore, it would be interesting to get more survey-based content. Currently this project is purely qualitative and there has not been any numerical data gathered or analyzed. As more data is collected, the project would morph into a mixed-methods study. This would allow for large scale validation of preliminary data and to understand the trends in the larger culture.

It is important to also get more faculty perspectives. From the student focus groups, the divide between what is taught and what students learned is wider than professors may assume. For this reason, it is important to go back to the faculty and get an updated reflection. It would also prove worthy to discuss the overall results and themes with the co-op department, to better understand their role in this skill discrepancy. They have been involved with the initial development of the research question, but it would be nice to follow-up with them and get their perspective on the model and results. This would also prove beneficial when trying to develop training modules or crash courses for the co-op program.

One perspective not yet explored in this study is the employer's. They would be vital in our understanding of student performance and employability skills in practise. Because of the lack of data in this preliminary phase, reaching out to employers is not yet efficient, but once more information is gathered, employers can provide a lot of good insight into which

specific skills need to be worked on before entering the field and which will be developed throughout the co-op experience.

It is important to study the written curriculum and understand how that may impact a discipline's culture and skill development. Considering the fact that co-op programs adhere to the competencies listed by governing engineering bodies, such as CEAB and ABET, tracking this model according to those competencies would provide a unique perspective. Interviews and focus groups capture the experience of education, but do not capture the unbiased knowledge that is expected to be gained. Also, each of these disciplines in this institute is run by independent departments and do not have any sort of overlapping for assessments. This means that there is no one way to track how employability skills may be taught. The similarity is the competencies discussed above. This is why it would prove beneficial to track and map skill development through each discipline's curriculum.

Finally, this study currently only exists within one institute. By further developing this study and model, the next step is to create a framework for this to be done in other institutes. This would allow every engineering program to understand its disciplines and provide their own students with the skills to succeed, with less variance.



Appendix A1: Model For Study

Teamwork	Working in a Multidisciplinary Team	<i>In a company that has various worker and moving parts, employees need to work with and learn from different specialities</i>
	Interpersonal Understanding	<i>One must be able to understand the people on their team. this includes having emotional intelligence for the other, empathy, and keeping modes of communications open and respectful</i>
	Leadership Qualities	<i>Being in a team means adapting to various roles, including leadership ones. Being a leader means exercising cooperation, conflict resolution and developing others/mentorship</i>
	Project management	<i>Management of a team and its tasks is a part of being in an ever-changing industry.</i>
	Relationship building	<i>When working with new teammates, one must be able to connect with one another. This means building a relationship based on trust and mutual respect. Building such relationships is a skill to be honed and developed.</i>
Critical Thinking	Application of theoretical knowledge, for real world problems	<i>Taking knowledge taught in academic settings and applying it to real-world problems.</i>
	Creativity	<i>Thinking of things with a new perspective opens gates to new solutions.</i>
	Deal with ambiguity and complexity	<i>Instead of being solution oriented, ambiguity and complexity makes one think of things from different angles.</i>
	Design	<i>Using design thinking and tools to effectively design for various systems, experiments and maintaining safety regulations</i>
	Pattern recognition	<i>Pattern recognition is part of critical thinking; it involves learning repetitive behaviour and finding hidden patterns when they occur.</i>
	Engineering and mathematical	<i>To practise and apply, one must know about the basic fundamentals that make up a</i>

Knowledge Acquisition	fundamentals	<i>knowledge base.</i>
	Ability to be curious and continuously learn	<i>As the world rapidly changes, one must be ready to learn for the duration of their career.</i>
	Adapting to new technology	<i>Technological growth is inevitable and makes engineering more efficient. One must be willing and learn this new technology as it is implemented.</i>
	Business knowledge	<i>Engineering exists in conjunction with many disciplines and quite closely with the business realm. It calls for the understanding of economics, finance, marketing, management and data analysis</i>
Communication	Verbal	<i>In this form, communication means to be effective in: public speaking, meeting engagement and presenting ideas clearly.</i>
	Written	<i>In this form, communication includes technical report writing and online correspondences</i>
	Giving and accepting constructive criticism	<i>Communication is about listening and using feedback to make personal and professional improvements. It also goes in the opposite direction.</i>
	Adapting to audiences, ranging from clients to managers	<i>Depending on the audience, tone, directiveness, language and conversations must be adjusted for better understanding and conversations.</i>
Initiative	Willing to take risk	<i>Many times, the definitive outcome is unknown; one must be able to move forward in this ambiguity and rely on personal skills to succeed</i>
	Personal drive	<i>The willingness to go above and beyond for good quality work must be self-motivated</i>
	Ingenuity	<i>This is the quality of being clever, original and inventive with one's decisions</i>
	Autonomy	<i>This is the ability to make decisions, unprompted or influenced.</i>

	Accountability	<i>This includes taking ownership of one's own work, having the flexibility and the ability to adapt to different environments, maintaining a quality of work, and being dependable.</i>
Problem Solving	Analyzing and diagnosing to fully identify the problem	<i>Before solving, the problem field must fully be understood, so as not to get caught up in being solution-oriented.</i>
	Timely decision making	<i>Timelines must move forward and this can only happen when each process ends. This allows a project to move forward with minimal consequences.</i>
	Information seeking and management	<i>One must be able to find relevant and accurate information, to not compromise the integrity of the institution of employment.</i>
	Taking into account various perspectives	<i>Problems are multi-faceted and affect many stakeholders; for this reason, one must be able to converse with relevant parties.</i>
Organization	Time management	<i>Using various tools to manage one's time, so as to not lose track of important deadlines and expectations.</i>
	Prioritizing	<i>Work is not linear and many times different things are happening during the same timeline; one must be able to critically see the important tasks and make relevant sacrifices.</i>
	Multi-tasking	<i>Alongside making compromises, one must be fluid and able to work on different projects without diminishing the quality of the overall work.</i>
	Goal and task setting and management	<i>One must be able to keep the big picture in mind, while also focusing on the individual components that need to be addressed, in a manner that is efficient.</i>
Personal and Social Ethical Intelligence	High ethical standards and integrity	<i>Practises must be in accordance with regulations and a personal and professional code of conduct</i>
	Technological responsibility	<i>The power of technology is vast; this means that it must be used with care and professionalism.</i>

	Self-regulation and personal ethics	<i>Micro-management is not possible with personal ethics; this means that boundaries and expectations need to be set for the self, by the self.</i>
	Global and social intelligence	<i>Being unaware of the rest of the world is a mistake that can have grave consequences; one must be constantly educated and willing to learn</i>
	Environmental awareness and responsibility	<i>The environment must be considered in various aspects of the job, to ensure practices that are beneficial to the largest group of people.</i>
	Understanding of unintended consequences	<i>Especially in this technologically growing market, one must always keep in mind the unintended consequences of actions and put the work in to be aware of potential ones.</i>

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