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## **Student Perceptions of Connections Between an Introductory Dynamic Systems Class and Co-Op Work Experience**

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## **Abstract**

This work focuses on connections that students see between co-op work assignments and a specific class in their mechanical engineering curriculum, typically taken in the second half of their junior year or the first half of their senior year. Students in the course wrote an essay, as a required assignment, in which they reflected on the links between their co-op work and the course, and were asked for permission to use those essays in the professor's research on this topic. Analysis of the essays shows that students typically did see connections; in many cases, these were connected to the course content. However, in other cases, students noted that they had learned problem-solving skills, time management, or other skills that were not directly connected to the class content, which were also useful in their co-op assignments and future careers. The results of this work can be used to motivate students in this or similar courses by showing them how the material is relevant to them. In addition, instructors for other courses may find the essay assignment relevant in their own attempts to prompt students to make connections of this nature between their formal classroom experiences and co-op or internship experiences.

## **Introduction**

At Kettering University, all students are required to complete a number of co-op work assignments in order to graduate with their engineering degree. These can be in a wide variety of different industries, and encompass many different types of jobs. Therefore, they may relate more to some courses in a student's curriculum, and less to others. Furthermore, some connections may not be obvious, particularly in a more abstract or mathematically focused course. Making these connections, however, can be a powerful tool in motivating students to learn difficult material, as well as helping them in their future careers where they may need to use it.

In this study, students examined connections between a senior-level course in Dynamic Systems and their co-op work experience through an essay assignment. As the students had experienced several co-op terms, they had a wealth of experience to draw on, with some experiencing multiple different types of engineering jobs and others delving deeper into a single type of experience. Typically, students considered their most recent co-op experiences. However, those who were without a current co-op, or who had multiple different types of co-op experiences, were given the option to choose from their experiences and write about whichever one they felt was best suited to the assignment.

## **Background**

Co-op work experience has long been acknowledged as an important method for experiential learning that has multiple benefits. Some of these benefits include the development of enhanced professional skills such as communication skills [1], leadership [2], and understanding how coursework relates to engineering practice [1], [3], [4]. Several studies have been conducted on how engineering coursework and co-op experiences interact [3], [4], [5], and have shown clear benefits to the co-op experiences. To achieve maximum benefit, however, the co-op experience must be explicitly and methodically connected to the student's education, rather than leaving it to the individual students to independently figure out what the relation is between their co-op work and their coursework [3].

One method to assist students in making connections is through written reflections. Such reflections have been used within particular courses, such as Socha, et al.'s integration of reflective practices into software engineering [6] and Reidsema and Mort's use of reflective writing in an engineering design course [7]. The integration of reflection into engineering education in a broader sense was studied by Turns, et al. [8], and recent work by Badenhorst, et al. [9] described reflective writing as a specific "new literacy" for engineering students. Furthermore, reflective writing has been applied specifically to learning from internships and co-ops, as described by Minnes, et al. [10] and Peters and Arbor [11]. This can be done in several

ways; Minnes, et al. utilized weekly reflections throughout a summer internship, while Peters and Arbor utilized a single written piece within the context of a particular class, as in this study. In that case, the class was sophomore level, while in this study, a senior-level class was the context; therefore, it can be expected that students will see different levels and types of connections, as they have had more experience both in the classroom and in the workplace.

## **Methods**

As part of a senior-level course at Kettering University, focused on the mathematical modeling of dynamic systems, students were asked to write an essay describing the relationship they saw between the class and their co-op work experience. The essay prompt indicated that they should describe their co-op work assignment, describe the class content in their own words, and then discuss that relationship. They were specifically told that the relationships could focus on the class content, problem solving skills, or some combination of the two. The specific essay prompt is given in the appendix. Over two academic terms, 115 students were enrolled in four different lecture sections that had this assignment, with 114 students completing the assignment.

Students were also asked for permission to use their essays, with all identifying details redacted, in the research documented in this paper. In accordance with an IRB-approved protocol, students were instructed to submit their consent document for this to the lab instructor, who retained control of them until after final grades were submitted, thus ensuring that there would be no impact on students' grades. Twelve students from the first term and nineteen students from the second term gave this consent. These participants included 24 male students and 7 female students.

The essays submitted by these students were anonymized, with pseudonyms assigned to each essay. Pseudonyms were assigned at random by gender identity, with the only check being to make sure that a pseudonym did not match the person's actual name. Names of the students' co-op employers were also removed in order to ensure anonymity. The essays were then analyzed using a pre-determined codebook, as given in Table 1.

Table 1: Codebook for Analysis of Essays

Degree of linkage through class content	High: student sees clear connections between class material and their job. They have either used the class concepts, or see how they could be used.
	Moderate: student sees some connections between the class material and their job, but it's somewhat tenuous. The overall concepts may be useful, but they aren't directly applied.
	Low: student sees few, if any, connections between the class material and their job.
Number of connections through class content	Each specific, distinct item is counted separately. If there are multiple elements of a single concept, it is counted once unless those elements are large and distinct in their own right.
Connections through problem solving	High: student sees clear ways that their problem-solving abilities have been enhanced by the class, and how that could help them in their job.
	Moderate: student sees some ways that their problem-solving abilities have improved, but is not able to draw a clear connection to their job.
	Low: student does not discuss problem-solving abilities in depth if at all.
Number of connections through problem solving	Similarly to the number of connections through content, items are counted as being distinct if they can stand alone in their own right.

In addition, the industries in which students worked were noted, in order to determine whether any correlations existed between the results of the analysis and students' specific industrial setting.

## Findings

While written assignments of various forms are required in many engineering courses, and writing has been found to aid in metacognition in technical classes [12], students are sometimes resistant to writing assignments, as noted in [13], [14], and may describe themselves as not being good at writing. However, the quality of their essays was generally good. This may be due to the way in which the assignment was framed; the professor for the class consciously tried to decrease the pressure on students, particularly during the stress of the ongoing COVID-19 pandemic, by reminding them that they were writing about something in which they were the experts, and that the grading would be based on how well they explained their viewpoint on the connections between the class and their work. Students appeared to put a strong effort into the assignment, with some of them coming up with clever titles and interesting anecdotes for their work. Some essays were simply titled with the assignment title from Blackboard, but others included titles like “The Correlations Between Real World Engineering and Education”, “The Links Between the Classroom and Work”, or “Work Desk vs School Desk.” The words in the titles are shown in the word cloud in Figure 1, with the course name/title removed.

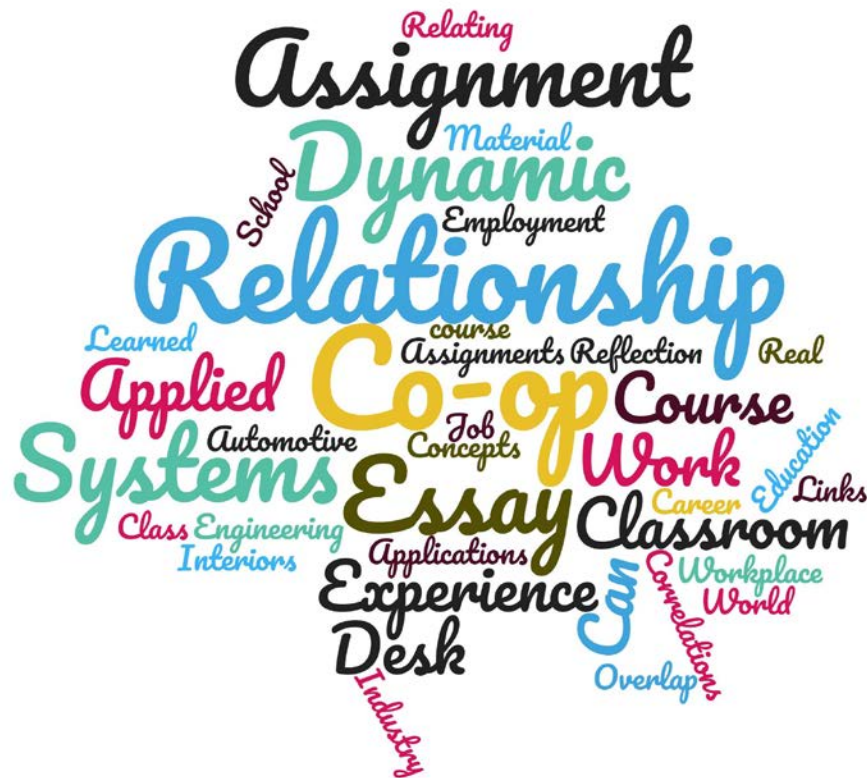


Figure 1: Word Cloud of Essay Titles

The quality of the submissions, and the amount of thought that students put into the titles, gives some initial indication of the value that students placed on the assignment. The fact that they took it seriously indicates that they value connections between their courses and their work experiences, although the sample may very well be biased by the likelihood of students who took it seriously allowing their essay to be used.

Correlations between the results of the various analyses and students' industries were not apparent, in large part because there were very few industries represented in the data. The overwhelming majority of the students worked in a company that was in some way involved with the automotive industry, with only four students working in companies that were not in some way involved with the automotive industry.

Students were evenly split on the degree to which they saw connections between class content and their co-op job, as shown in Figure 2.

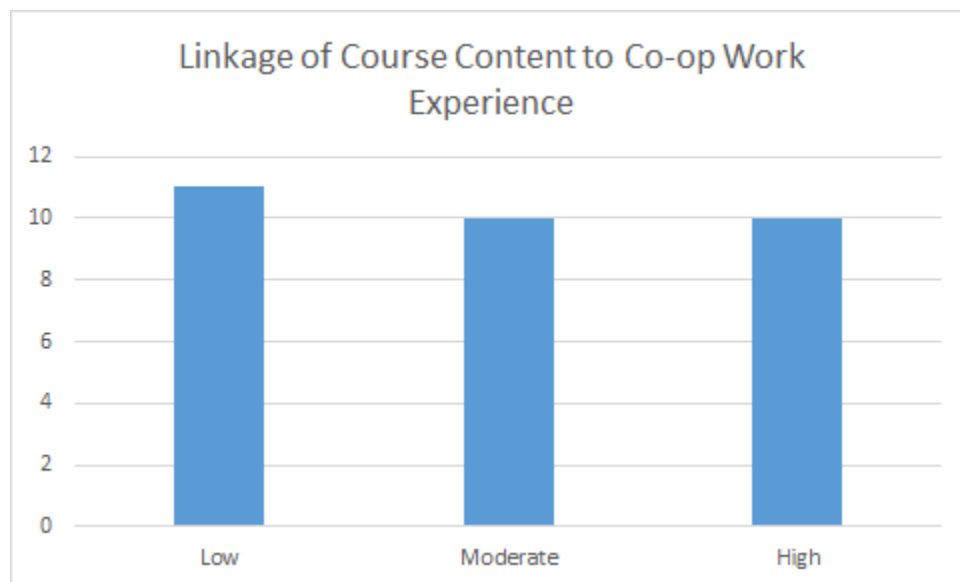


Figure 2: Student Perceptions of Links between Course Content and Co-op Work

Some students saw very strong connections, with one stating very strongly early in his essay that he could see these links. “Zane” started out his discussion of the class by stating

I don't think there is a better class I have taken thus far in my undergrad that better lines up with my co-op than MECH 330 has.

Similarly, “Elliott” indicated that there were clear links to his work.



The knowledge which I gained in MECH 330 very clearly links which (sic) my work at my co-op employer. In fact, a majority of the work I deal with involved dynamic systems.

Others, while they did not make such a strong statement, were able to articulate specific ways in which course content was linked to their jobs. The course content included several topics, including modeling of dynamic systems using two different approaches, transfer functions, and vibrations, as well as the use of MATLAB/Simulink. While all aspects of the class content were mentioned by some students, the most commonly cited aspect was the material on vibration that was included in the course. One example of this was seen in an essay from “Xenia.” She stated that

The vibrational aspect of the class had a direct correlation to the type of work I was doing as the main aspect of my job was working with natural frequency, which we often calculated and discussed how it represented the system and its behaviors as a whole.

However, there were other students who did not see such strong links between the course and their work experiences. Another student, “Taylor”, saw that the course material could be helpful in some areas, but not in what she was working in at the time.

Overall, I feel that this class may have not been currently relevant to what I am doing at my co-op, but it could possibly be helpful in the future if I decided to switch employers.

Overall, the number of specific, distinct items mentioned by students ranged from zero to four, with an average of 1.6.

Essays were also analyzed for non-content-based connections, which were defined for purposes of this study as those connections based in any skills that could be learned in a class that were not uniquely tied to the class content itself. This could include problem-solving skills that could be applied to a wide range of tasks, time management, writing or reflection skills, teamwork, or the ability to carry out an engineering project. Students provided fewer examples of non-content-based connections between the class and their co-op jobs, with an average of 1.1 specific items listed, and overall exhibited a lower level of perceived connections in this area. The majority of the essays showed a low level of connection there, with only a few exhibiting high levels of connection through problem-solving skills, as shown in Figure 3. Problem-solving skills were emphasized by the instructor and mentioned as an example of these kinds of skills in the essay prompt, which may explain why students explicitly thought about them in particular.

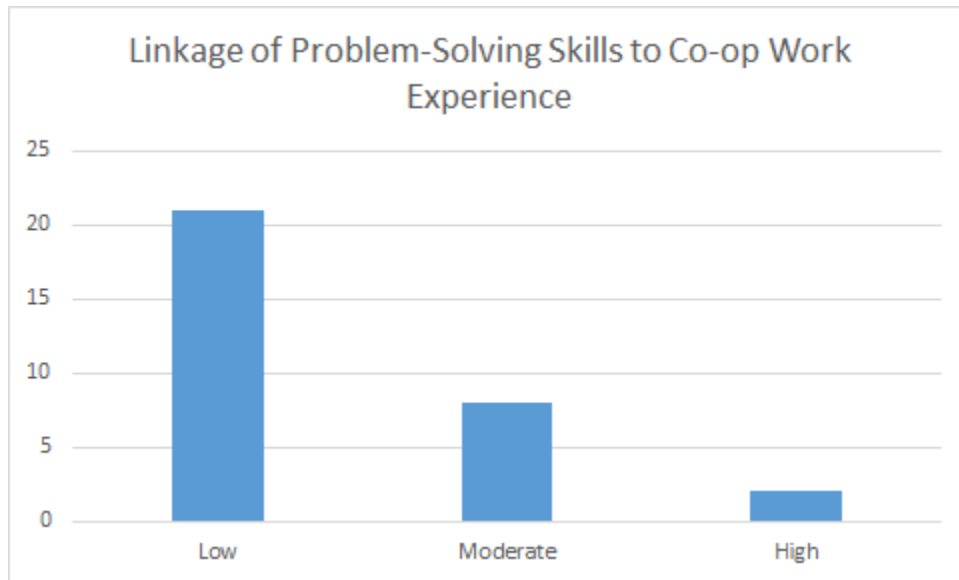


Figure 3: Student Perceptions of Links between Course Skill Development and Co-op Work

Generally, students did not explicitly state that links did not exist, but simply did not discuss them. Some students did show a moderate to high level of linkage, however. One example of this was seen in the essay from “Chris”, in which he spoke of the class project. While his job did not use the class content, he felt that the exercise of applying class content to some type of real-world system was good practice.

I think the biggest link to my co-op this class has is taking a real-world system and applying our classroom knowledge like in our final project.

Other students spoke of general skills they had gained or practiced in the class, such as organizational skills, paying attention to details, time management, and teamwork. One student, “Adam”, focused on this.

One of the most practical skills that I correlate between my co-op and schoolwork is keeping your work organized. This may seem trivial but keeping your work organized is one of the most important aspects to getting a job done.

Another student, “Kyle,” felt that they gained an improvement in problem-solving skills specifically in the area of interpretation and choosing how to solve the problem.

MECH 330 has definitely taught me a lot more about problem solving skills because I learned how to analyze data more efficiently and taught me that there is more than one way of interpreting a question and different methods to tackle the problem.

Students' views on the general value of the class, outside of any links based on the content, were best summarized by "Larry".

Regardless of a slight disconnect between my current position at {Company Name} and the content covered in DS1, I believe I will be a much better engineer for what I have learned here and will be better off for it.

When analyzing these results, it was seen that those students who saw a high level of correlation between course content and their jobs did not generally discuss the more general problem-solving skills they had gained.

Table 2: Number of Students Exhibiting Levels of Connections

Course Content	High	9	1	0
	Moderate	7	2	1
	Low	5	5	1
		Low	Moderate	High
		Problem Solving		

Those students who saw a low level of connection between class content and their jobs were more likely to exhibit at least a moderate level of connection between their jobs and problem-solving skills that they were learning, while no one who saw a high level of connection in the course content also exhibited a high level of connection in problem solving skills.

Correlations between the number of distinct connections seen for course content and for problem solving were examined, with the results shown in Figure 4. The size of the marker in that figure indicates the number of cases where that combination occurred, with the smallest markers representing one occurrence and the largest representing five occurrences.

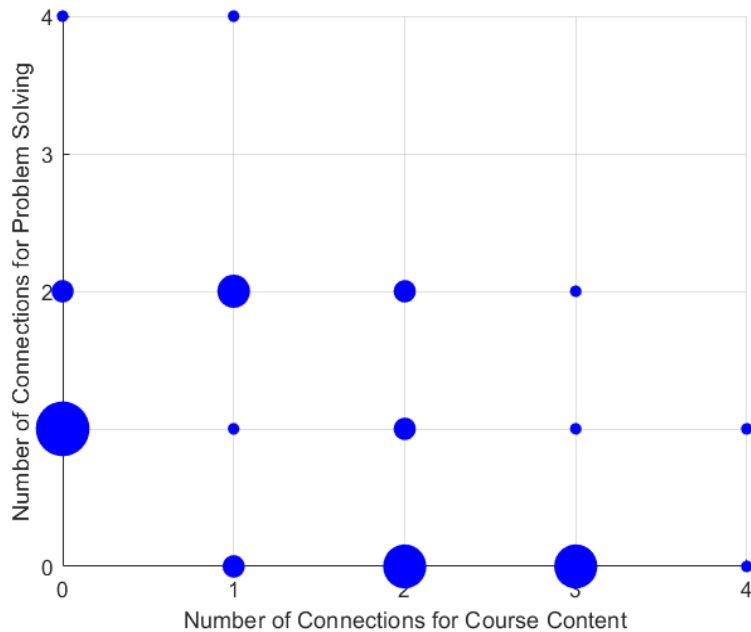


Figure 4: Comparison of Connections through Course Content and Problem Solving Skills

Note that no students saw zero correlations in both categories, and the trend holds here as well that those who saw strong connections between the class content and their co-op work reported fewer connections regarding problem-solving skills.

## Discussion

The degree to which students' work experience and the class content varied was not surprising, given that engineering jobs cover a broad range of different types of tasks. Those who indicated connections existed seemed to feel very strongly about those connections, as exhibited by some of the quotes excerpted in the previous section. Whether or not they would have seen those connections without prompting is an open question, however; the essay assignment itself, aside from showing how they connected the class material to their work, could very likely have caused them to draw those connections. In fact, in some cases it is abundantly clear that it did, as one student, "Urbain", said that

Going back and relating MECH 330's material to work I have done in the real-world help's (sic) me learn even more from the co-op experience than I had already.

Similar sentiments were expressed by other students, although this quote was the most concise and articulate expression. This indicates that, while the assignment was useful for revealing what connections exist, it was also valuable for prompting students to make those connections. That aligns with the literature on reflection, which indicates that writing is one means of prompting

students to reflect on their experiences; it also affirms the literature on co-op and internship work experiences. As stated in [3], students do not automatically make the connections themselves, and therefore instructor guidance in doing so is necessary for them to receive the maximum benefit from the experiences.

The observation that students reporting a high level of connection through course content did not generally see a high level of connection through problem solving skills, while interesting, may reflect the way in which they approached the assignment. Students tended to write first about the course content itself, then about the problem solving skills they had gained. Those who had extensive connections through the content may have decided, consciously or unconsciously, that their essay was long enough or good enough to meet the requirements of the assignment, and not spent time thinking about any connections beyond the course content, while those who saw few or weak connections through course content may have felt that they needed to think about and include those other aspects.

There are several limitations of this study. One is that those students whose essays are included here are self-selected, by necessity. They represent approximately 27% of the students who took the course across the two academic terms considered. While this is a substantial proportion of the student body in the classes, it does raise the question of how representative this sample is. Due to anonymity, grades for these students are not tabulated, so there is no way to know whether they are representative of the range of performance seen in the class. The students do appear to be representative in terms of gender; among those who gave consent for their essays to be used, 23% were female, as compared to 20% for the overall population in the classes.

## **Conclusion**

The students in this study saw clear connections between their co-op work assignments and the class in many cases, and those who did not see such connections were able to articulate why not, see how the class could be useful to others, and point out ways in which their problem-solving skills were enhanced by what they learned. These connections can be used to increase motivation, and may aid in retention of material. Students, however, did require some prompting to make the connections, and one consequence of this study is to show the value of assignments where students are prompted to do so. Both the process and the product are useful, and can be integrated by instructors into a variety of settings, based on student work experiences and their own courses that they teach

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## References

- [1] K. M. Ehlert and M. K. Orr, "Understanding how co-op students view their learning," in *Proceedings of the ASEE Annual Conference*, Virtual, June 2020.
- [2] K. P. Kelley and S. T. McGonagle, "Leveraging co-op experiences to enhance engineering students' leadership skills," in *Proceedings of the ASEE Annual Conference*, Atlanta, GA, June 2013.
- [3] J. El-Sayed and D. Stodola, "Integrating co-op and classroom learning experiences," in *Proceedings of the ASEE Annual Conference*, Austin, TX, June 2009.
- [4] J. Wojciechowski and C. Standridge, "The mutual re-enforcement of curricular education and co-operative education: A case study," in *Proceedings of the ASEE Annual Conference*, Louisville, KY, June 2010.
- [5] C. R. Noyes, J. Gordon, and J. Ludlum, "The academic effects of cooperative education experiences: Does co-op make a difference in engineering coursework?," in *Proceedings of the ASEE Annual Conference*, Vancouver, BC, June 2011.
- [6] D. Socha, V. Razmov, and E. Davis, "Teaching reflective skills in an engineering course," in *Proceedings of the ASEE Annual Conference*, Nashville, TN, June 2003.
- [7] C. Reidsema and P. Mort, "Assessing reflective writing: Analysis of reflective writing in an engineering design course," *Journal of Academic Language & Learning*, vol. 3 (2), pp. A-117 - A-129, 2009.
- [8] J. A. Turns, B. Sattler, K. Yasuhara, J. L. Borgford-Parnell, and C. J. Altman, "Integrating reflection into engineering education," in *Proceedings of the ASEE Annual Conference*, Indianapolis, IN, June 2014.
- [9] C. M. Badenhorst, C. Moloney, and J. Rosales, "New literacies for engineering students: Critical reflective-writing practice," *The Canadian Journal for the Scholarship of Teaching and Learning*, vol. 11 (1), pp. 1 - 20, 2020.
- [10] M. Minnes, J. Mayberry, M. Soto, and J. Hargis, "Practice makes deeper? Regular reflective writing during engineering internships," *Journal of Transformative Learning*, vol. 4 (2), pp. 7 - 20, 2017.
- [11] D. L. Peters and J. Arbor, "Student perceptions of connections between statics class and co-op work experience," in *Proceedings of the ASEE Annual Conference*, Indianapolis, IN, June 2014.
- [12] M. Castellanos and J. A. Enszer, "Promoting metacognition through writing exercises in chemical engineering," in *Proceedings of the ASEE Annual Conference*, Seattle, WA, June 2015.
- [13] R. Moore and J. Strueber, "Writing assignments for technical courses," in *Proceedings of the ASEE Annual Conference*, Salt Lake City, UT, June 2004.

- [14] N. T. Buswell, B. K. Jesiek, C. Troy, J. Boyd, and R. R. Essig, "Engineering faculty on writing: What they think and what they want," in *Proceedings of the ASEE Annual Conference*, New Orleans, LA, June 2016.

## **Appendix**

The information below was on the assignment sheet given to students in the course. This was the specific essay prompt, including the purpose and required structure of the essay.

### **Purpose:**

The purpose of this assignment is for students to reflect on how the facts, techniques, and skills learned in COURSE NUMBER can be useful in their co-op job, and/or how their co-op job impacts their view of the material learned in class.

### **Structure:**

The essay should contain the following elements. These are not separate questions; there should be a logical flow and transitions between the paragraphs.

- A description of your co-op assignment, with sufficient detail so that a reader could understand what industry the company is in, what they do in general, and what your specific role is. You may also include information on what you plan or hope to do in future co-op terms, if this is different than what you've done to date.
- A description of what you feel you're learning in COURSE NUMBER. This must include a description of the course content, but may also include skills such as general problem-solving skills. Be as specific as possible about this; it should be at least a full paragraph.
- Your thoughts on what the links are between your co-op assignment on the content and skills you learn in COURSE NUMBER. Spend some time, and write as extensively as possible, on this part of the essay. If you feel there are very few links between the course content and your co-op assignment, discuss why this is the case, then focus on more general problem-solving skills.
- A brief conclusion, in which you summarize and tie together the most important things (in your opinion) that you've said in the essay