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Implementing community-engaged learning (CEL) in a second-year engineering design course

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Abstract

Community engaged learning (CEL) was integrated into a second-year chemical engineering design course. The CEL project focused on assessing the impact of food delivery on campus on GHG emissions. Students were surveyed before and after engaging in the CEL project where they self-assessed a number of skills and then answered a variety of open-ended questions on their experiences. Overall students reported being slightly more confident in understanding how engineering theory connects with community experiences. Students indicated far greater understanding of CEL following completion of the project. Student also indicated they got less out of the CEL experience than anticipated. Potential reasons for this that students indicated were the project being at the end of term, where other major course deliverables were due, as well as not having as much engagement as anticipated when performing data collection.

Keywords

Community engaged learning, impact of engineering on society

Introduction

Community engaged learning (CEL) involves students interacting with community groups through a partnership which provides benefits to the community group and furthers student learning. Within literature service learning is one common form of CEL. There is a rich history of CEL in engineering curriculum [1]. CEL has been found to provide a number of benefits including motivation for social engagement [2], communication skills development[3] and academic benefits [4], [5].

Given these benefits, CEL was integrated into a second-year chemical engineering design course in order to enhance skill development in students and with a particular focus on Engineers Canada Graduate Attribute (GA) development [6]. In particular we focus on GA 9 being the impact of engineering on society and the environment. The integration of CEL was done in partnership with the Centre for Community Engaged Learning (CCEL) at the University of British Columbia Vancouver (UBC-V) Campus.

Course and project details

The course consisted of 125 students and has three hours of lecture and two hours of tutorial per week. Tutorial sessions are used for students to work in teams of four to five students on several design deliverables for the first nine weeks of the term. Following this, teams were then assigned to work on a CEL project during the tutorial sessions for the last three weeks of the term. Teams and design deliverables are coordinated with a communications course occurring the same term. Students submit project documents to both courses and receive feedback and a grade from each course.

The CCEL runs a fellows program where undergraduate students are hired on a part-time basis to assist in implementing CEL in a course. The cohort of CEL fellows participate in training workshops on CEL in July and August and have cohort meetings during the main academic terms from September to April. During this project two fellows, being 3rd and 4th year undergraduate students were hired to assist with program implementation.

Principles of community-based action research (CBAR) informed the development of the project. This included the engagement of a variety of stakeholders in developing the project scope. In the end the project focused on sustainability at UBC-V and specifically the UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program which creates partnerships between students, faculty, staff, and community partners. The project focused on assessing greenhouse gas (GHG) emissions from food delivery services to student residences. A project was selected based on several criteria. Notably the project had to be relevant to engineering training, it also had to be something implementable by many teams (in this case 26). Other items explored included waste audits at food service sites and campus transportation data collection.

Students were familiarized to the specific project by reading a news article related to the issue to be studied. Students were then individually surveyed on their opinions on CEL before the project was presented (pre survey). In the first tutorial session students were presented with a background and rationale for the study. Data collection locations, being certain residences, and the rationale for these choices were shared with the students. Students then chose a location and time to collect data. Data collection times focused on two-hour periods in the evenings (rather than around noon) so as to not disrupt class schedules. Expected project outcomes were also discussed and students were expected to produce a 1000-1200 word memo report outlining their data collection and GHG emissions assessment. Following the project, students completed another individual survey and self-reflection exercise (post survey). Student data on deliveries collected from the project was then passed on to a co-curricular student group, Engineers for a Sustainable World, for further analysis to create an estimate for campus GHG emissions from food delivery services.

The main data collection method used to assess the impact of the CEL project was a pre and post survey. Questions for the survey were adapted from a standard survey from the CCEL. Copies of survey questions can be found in Appendix A. An initial bank of eight Likert scale questions was

used for students to self-assess their understanding of CEL and impact of engineering on society. These questions used a five-point Likert scale from strongly agree to strongly disagree. Following the Likert scale questions, a set of open-ended questions were posed.

Results and Discussion

Of 125 students in the course, 44 students, representing 35% of students in the course completed the pre and post surveys and consented to their data being used for an analysis of the impact of CEL in the course. Results for Likert scale for the pre survey are presented in Figure 1, with results from the same questions in the post survey presented in Figure 2.

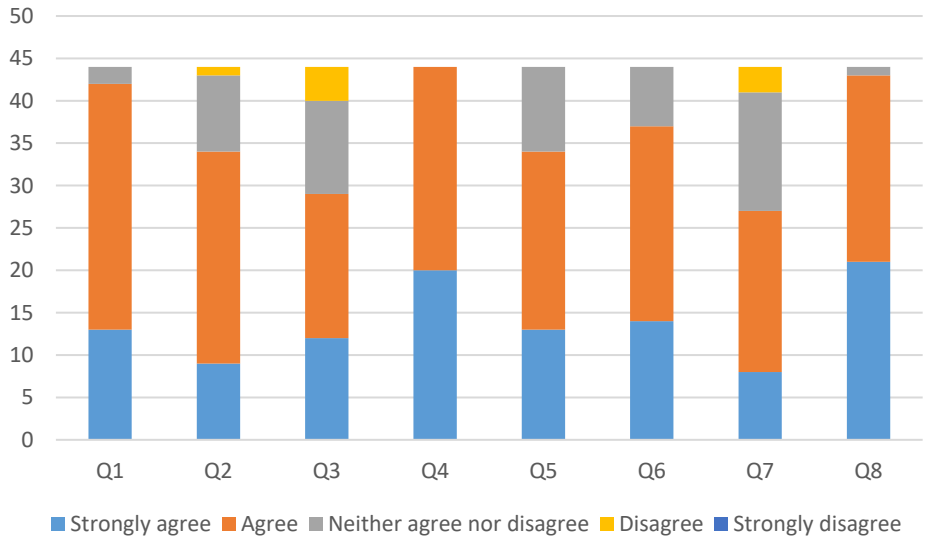

Figure 1: Student responses to Likert scale questions prior to engaging in the CEL project (Pre)

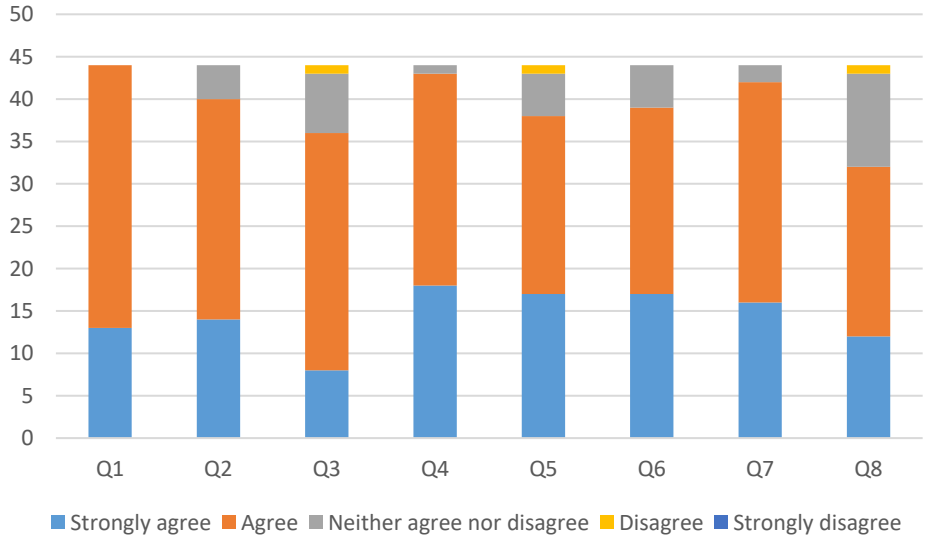

Figure 2: Student responses to Likert scale questions following the CEL project (Post)

Table 1: p-values from a t-test assessing differences in pre and post survey

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
P-value	0.6702	0.05644	0.4337	0.5409	0.3132	0.4285	0.0002166	0.001467

Likert responses were assigned a value of 5 for strongly agree to 1 for strongly disagree. These results were then analyzed for significant differences using a two-sample t-test assuming unequal variances **[7]**. P-values from these tests are presented in Table 1, note that all but the results for Q7 and Q8 do not meet significance criteria of being less than 0.05. Changes in responses pre vs post are shown in table 2. These generally show similar increases or decreases amongst students for Q1 to Q6, but as noted with the t-test, a significant increase for Q7 and for Q8. The small changes in Q1 to Q6 may indicate the experience may not be significant enough to change these attitudes, and they may be better placed in a course with a longer or more deeply embedded CEL project. The high scores on the questions also indicate that more critical questions could be posed. Having gone through the experience students rate that they have a better understanding of what CEL is (Q7), however students had a higher expectation of the value of CEL to their own learning prior to the project.

Table 2: Changes in individual respondent answers pre vs post (all columns total to 44 responses)

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Large decrease (<-2)	0	0	2	0	1	0	0	2
Slight decrease (-1)	8	6	10	11	6	6	3	19
No change (0)	27	22	15	25	23	27	21	21
Slight increase (+1)	8	14	13	8	13	11	12	2
Large increase (>+2)	1	2	4	0	1	0	8	0

The open-ended responses may help in understanding the Likert responses and a thematic analysis was performed on responses to open-ended questions. Responses from post-survey Q9, Q10 and Q11 were analyzed and coded using an inductive reflexive thematic analysis **[8], [9]**. Themes appearing more than once for each question are presented in table 3 Responses from the other open-ended questions, being pre-survey Q9, and post-survey Q12, were minimal with less than 10 responses provided. Responses to these questions did not present significantly different themes to those captured in the questions analyzed.

Table 3: Themes identified and frequency of repeated themes in open-ended questions

Q9 What is one aspect of your CEL experience in CHBE 220 that you would like to continue in future CHBE courses?		**Q10 What is one aspect of your CEL experience in CHBE 220 that could have improved your engagement with the community and the course?**		**Q11 What is one thing about your CEL experience that you would have done differently? (What would you change in terms of what you did during the experience)**	
Theme	**Freq.**	**Theme**	**Freq.**	**Theme**	**Freq.**
Real-world problems	14	Engaging with community members	7	More active data collection	10
Field work/data collection outside of class	12	Earlier in term	6	More data collection	6
Contributing to community	10	More effective data collection	6	More freedom in data collection	5
Better understanding engineering and society/community	6	More flexible data collection times	4	Different data collection times	5
Teamwork	2	Deeper understanding of community/stakeholder	3	Different data collection location	4
Sustainability	2	Teams working together	3	Longer project	4
		More data collection	2	More active participation	3
		More guidance on project/data collection	2	More community interaction	3
		Different topic	2	More background research	2
				Better team organization	2

In terms of what aspects of their experience students would like to continue (Q9), many students focused on the real-world nature of the problems and collection of data outside of class. Students also mentioned enjoying contributing to the community and better understanding links between engineering and society or the community. A few representative responses from students speaking to these points are copied below.

"Being able to participate in a project where actual real world application is required adds a lot of experience in learning other aspect that are important in engineering. Not only

focusing on learning material but applying the gained knowledge of the material in the real world."

"I like how the CEL tackled issues that are present on a broader scale than chemical engineering. All of my courses this semester were quite specific and technical, so I appreciated something more interactive with societal issues."

In terms of improving engagement with the community and the course (Q10), student responses focused on further engagement with community members. During data collection student groups may not have had a chance to explain why they were undertaking the study. Several students mentioned wanting the project to be outlined earlier in the term to provide more time for working on the project and clash less with end of term deliverables. Multiple responses focused on data collection practices including providing more guidance and tools around interacting with residents and delivery drivers on collecting data. Some representative responses speaking to these points are quoted below.

"Further interaction with the community could have better. In our group, we mostly had to observe and occasionally we were able to interview the delivery drivers."

"One aspect of my CEL experience that could have improved my engagement with the community and the course is the data collection and the way it was conducted. Perhaps if there was a more organized way to interact with the residences about their choices about food delivery options, we could have gathered more information on what we can do to reduce CO2e associated with food delivery."

Responses from Q11 on what students would change regarding the experience (Q11) built on responses from Q10. Many responses focused on data collection. Students wanted to be able to further engage with residents and delivery drivers and suggested splitting their teams to be able to collect and analyze richer data sets. Some suggested having a longer project timeline in order to be able to do this data collection.

Student comments suggest reasons that students found they had a lower expectation of the impact of this CEL experience on their education, with many wanting to further engage with community members. Providing further guidance or opportunities for community engagement will be explored in future project iterations. Overall it seems the CEL project provided some value to students based on their responses and reflections. However the CEL project also required significant instructor and CEL fellow time in preparing. Given this time investment having a longer project timeline or further opportunities for student engagement with the topic and community may be helpful in order to reap the benefit of setting up this experience.

Conclusion

A CEL project was implemented in a second-year chemical engineering design course. Following the project students indicated a better understanding of what CEL is, however students indicated that this CEL project had less of an impact on their education than expected. Student comments indicate they enjoyed working on a real-world problem, but want further opportunity to engage with the topic and community members. Given the effort in setting up the CEL project,

future project iterations will seek to incorporate further opportunities for student interaction with the community.

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Appendix A: Survey questions

Present in both Pre and Post Survey

The below questions assess your general views in relation to Community Engaged Learning (CEL). [Response options include Strongly agree, Agree, Neither agree nor disagree, Disagree and Strongly disagree]

Q1. I understand the role of engineering in society

Q2. I understand how engineering theory connects with community experiences

Q3. I understand the societal issues that the local UBC community is facing

Q4. I take responsibility for different aspects of my learning

Q5. People outside of the classroom are co-teachers in my university education

Q6. I can articulate my values in relation to a social issue

Q7. I understand what community engaged learning is

Q8. Overall, I expect my community engaged learning project in this course to be valuable to my own learning

Present in Pre Survey only [Open response questions]

Q9. Use the space below to share any further comments about the above questions or community engaged learning.

Present in Post Survey only [Open response questions]

Q9. What is one aspect of your CEL experience in CHBE 220 that you would like to continue in future CHBE courses?

Q10. What is one aspect of your CEL experience in CHBE 220 that could have improved your engagement with the community and the course?

Q11. What is one thing about your CEL experience that you would have done differently? (What would you change in terms of what you did during the experience)

Q12. Use the space below to share any further comments about the CEL experience.