Institute for Studies in Transdisciplinary Engineering Education and Practice
UNIVERSITY OF TORONTO

Online Learning and Teaching During the Pandemic: Engineering Students' Perspectives in 2020-2021

Reports on Survey Results

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Executive Summary

In response to the COVID-19 pandemic, all the courses shifted to online delivery at the University of Toronto in mid-March 2020, along with other Ontario universities. At the Faculty of Applied Science & Engineering (FASE), three student surveys (*FASE Undergraduate Student Surveys on Online Learning*) were administered to the undergraduate engineering students to capture student experiences during this unusual period of exclusively online teaching and learning: first in May 2020, and then in December 2020 and May 2021. These surveys became the basis of the research project "Engineering Students' Perceptions of Online Learning Experiences during the Pandemic."

The results from the May 2020 survey were reported in July 2020. The present document brings together a series of short reports based primarily on results from the December 2020 and May 2021 surveys. With different foci, these short reports will support quality improvement purposes within FASE. The knowledge generated has also been mobilized through research papers that have been published elsewhere, including one CEEA paper and one ASEE paper.

This document consists of **five sections**. These sections stand on their own and can be read as independent reports.

Section 1. Overall Quantitative Results from the December 2020 Survey

Section 2. Perceptions of Academic Workload: Results from the December 2020 Survey

Section 3. Comparison of May and December 2020 Survey Results: A Quantitative Analysis

Section 4. Comparison of December 2020 and May 2021 Survey Results

Section 5. Contributing Factors for Student Success in Learning Online During the Pandemic

The results in these sections directed us to the following **nine major observations** about teaching and learning in the online learning environment during the COVID-19 pandemic.

- Students' perceptions on online instruction remained mixed. The December 2020 survey results showed that 33% of the respondents provided a positive rating for the online instruction while 48% rated it negatively (Figure 1.1); the overall ratings were slightly lower than the May 2020 survey results but without a statistically significant difference (Figure 3.5).
- Staying active on online discussion forums, posting recorded class sessions, and offering synchronous office hours appeared to be most helpful ways for instructors to help students learn online (Table 1.1).
- Most students reported that less interaction with classmates created substantial challenges when learning online (Figure 1.2). Students found friends, social media groups, and mentorship helpful to their learning (Table 1.2), in addition to support from peers and instructors (Table 1.3). However, these interactions were less accessible in online.
- Perception of excessive workload constituted a major challenge for online learning. The December 2020 survey results showed that over 80% of the respondents perceived a higher academic workload in online learning than taking classes in person whereas half of the respondents felt so according to the May 2020 survey results (Figure 3.11), with a large effect size of the difference between the two points in time. Student-level factors and certain teaching-related factors appeared to have affected students' perception of academic workload (Section 2).

- Lack of motivation to learn was another major challenge for students in online learning environments. The majority of students did not enjoy online learning and felt less motivated to learn in online environments (61% and 79% respectively) although they mostly had interest in, and recognized the value of, the courses they took (84% and 90% respectively) (Table 1.3). The motivation issue became slightly worse in December (Figure 3.10).
- It was a challenging to run active learning activities online such as breakout room discussions. Assigning students to breakout groups in live class sessions appeared to be least helpful to the student's perceived learning (Table 1.1), with no improvement from May to December 2020 (Figure 3.4).
- Students' perceived mental health deteriorated as the pandemic continued on. The December 2020 survey results showed that 70% of respondents indicated that their mental health became somewhat or much worse when taking courses online in comparison with in-person course delivery (Figure 1.3), in comparison to nearly half of the respondents who felt so in the May survey results. These differences represented a medium effect size (Figure 3.14).
- Compared to the Fall Term 2020, a higher proportion of the Winter Term 2021 students:
    - favoured the use of inverted classroom approaches and instructors staying active on online discussion forums
    - found working on a team project outside of class very helpful
    - used different learning strategies when learning online than they would in person
    - agreed or strongly agreed that online instruction provided the same quality of education as in-person instruction.

  Moreover, a decreased proportion of students found learning with less interaction with their peers to be a substantial challenge. However, the effect sizes of all these improvements were small or very small.

  Students reported mixed responses to open-ended questions, which showed that some, but not most, Winter Term students:
    - felt that instructors tried harder to accommodate online teaching
    - experienced fewer challenges
    - reported they had adjusted their learning strategies to cope with the online environment.

  Moreover, more students indicated that they felt a deterioration than improvement in their mental health in the Winter Term (Section 4).
- Several environment-focused and individual-focused factors contributed to student success in learning online during the pandemic (Section 5). The environment-focused factors include:
    - Greater accessibility to lectures and course materials
    - Faculty-student interactions
    - Peer communication and collaboration
    - Changed approaches to learning assessment
    - Culture of care.

  The individual-focused factors include:
    - Student effort and agency
    - Saving commuting time
    - Social support from family and friends
    - Independent and self-motivated learning approaches.

Based on these observations, we would like to **recommend** that FASE communities take a collaborative approach to applying the valuable lessons learnt from our collective experience with online instruction as we transition back from online to primarily in-person instruction.

- *Enhance social interactions within the learning communities*. Social interaction was found to be one of the major challenges students faced with online learning. Instructors should strive to enhance and leverage the quality of student-to-student and student-to-instructor interactions as a central benefit to in-person learning.
- *Work together to support students' mental well-being*. Existing challenges with student mental well-being were accentuated throughout the transition to online learning. These challenges will remain as we transition back. Instructors, student life professionals, learning strategists and mental health professionals need to work together to help students develop learning strategies, such as time management, goal setting, help seeking, and motivation, resilience and perseverance.
- *Focus to reduce academic workload*. The related challenge of high academic workload also became accentuated when learning transitioned to online. Individual instructors should work to optimize workload when planning and delivering their courses. Better focusing workload can increase student learning and support their well-being. This is even more important when teaching online, given that more factors can contribute to students' perception of their academic workload when learning online.
- *Monitor students' transition back to in-person learning*. Students are experiencing another transition. There may be new adjustments and challenges for students, particularly those in first and second year unfamiliar with in-person learning at the post-secondary level. We recommend that the Faculty continue to monitor students' experiences and development during this transition so that appropriate actions can be taken to address any new challenges.
- *Retain and improve digital teaching techniques*. Instructors rapidly became familiar with a wide range of instructional technologies while teaching online. Instructors should continue to use these and other digital tools to enrich their in-person instruction and seek even more effective approaches to facilitate digital learning.[1] Teaching support offices should continue to support faculty members / instructors in enhancing the effective use of various teaching resources (in person, online and hybrid) to encourage better student engagement.
- *Leverage the positive experiences during the pandemic to further improve engineering education.* Our data suggested that the exclusively online environment in 2020-21 gave rise to greater accessibility to lectures and course materials and fostered innovative teaching practices, including approaches to learning assessment. We encourage individual instructors and the Faculty to continue this growth by leveraging the benefits of these changed practices in future teaching and learning.

Please contact Professor Greg Evans at greg.evans@utoronto.ca or Dr. Qin Liu at qinql.liu@utoronto.ca, should there be any questions about this document.

[1] Digital learning is an overarching term that captures all kinds of technology supported learning (CDLRA, 2021, p. 2). Canadian Digital Learning Research Association [CDLRA]. (2021). *Evolving definitions in digital learning: A national framework for categorizing commonly used terms*. Halifax, NS: CDLRA.

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Section 1. Overall Quantitative Results from the December 2020 Survey

The FASE Undergraduate Student Survey on Online Learning was administered from December 10, 2020 to January 18, 2021 to all undergraduate engineering students who took courses in the fall term 2020. A total of 503 students completed the survey, with a response rate of 10.4%; and another 156 students responded to some of the questions. This report presents the overall quantitative results from the analysis of the responses from all these students.

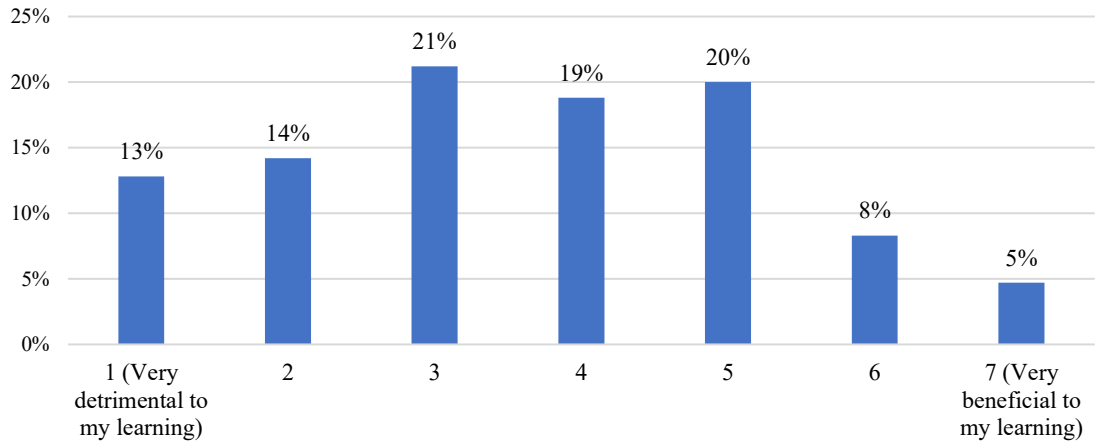
Below is a summary of the key findings from the descriptive data analysis. Detailed results are presented in the following sections of this report.

- Students' perceptions on online instruction were mixed. While 33% of the respondents provided a positive rating for the online instruction, 48% rated it negatively (Figure 1.1).
- The most helpful teaching strategies for students were instructor staying active on online discussion forum (87% indicating Helpful or Very Helpful) and posting recorded class sessions for student use (84%) whereas assigning students to breakout groups in live class sessions appeared to be least helpful (28%) (Table 1.1).
- Students found friends, social media groups, and mentorship helpful to their learning (Table 1.2), in addition to the support from peers and instructors (Table 1.3).
- The majority of students reported having experienced a substantial challenge in managing screen fatigue, participating in student clubs and other extra-curricular activities, and learning while having less interaction with classmates (Figure 1.2).
- The vast majority of the students (81%) perceived a higher academic workload in online learning than taking classes in person (Table 1.3).
- The majority of students did not enjoy online learning and felt less motivated to learn in the online environment (61% and 79% respectively) although they mostly had interest in, and recognized the value of, the courses they took (Table 1.3).
- Online learning had a negative impact, to varying degrees, on students' abilities to manage time, persist, seek help and set goals (Table 1.4). Students were better able to persist in their studies while they struggled with time management (Table 1.5).
- Most of the students expressed positive views about the Fall Study Break (Table 1.6).
- Seven out of ten students indicated that their mental health became somewhat or much worse when taking courses online in comparison with in-person course delivery (Figure 1.3).

Perceptions of Online Teaching

Figure 1.1 shows that while 33% of the respondents felt a positive impact of the online instruction on their learning (i.e., 5-7 on the Likert scale), 48% rated it as negative (i.e., 1-3 on the Likert scale).

Figure 1.1. Overall, I found that the online instruction this term was ... (n=515)



The ratings in Table 1.1 show that the most helpful teaching strategies for students were instructor staying active on online discussion forum (87%) and posting recorded class sessions for student use (84%) whereas assigning students to breakout groups in live class sessions was least helpful, with 28% of the respondents indicating Helpful or Very Helpful. In addition, a higher proportion of respondents found synchronous teaching and the use of the inverted classroom approach to be helpful or very helpful (69% and 66%) than those who rated asynchronous teaching as helpful or very helpful (50%).

Table 1.1. Ratings for Teaching Strategies

Teaching Strategies	Having been Used[1]	Helpful or Very Helpful[2]
Instructor stayed active on online discussion forum (e.g., Piazza).	89%	87%
Instructor recorded live class sessions and then posted them for student use at their discretion.	94%	84%
Instructor had live office hours.	82%	77%
Instructor did all the teaching through live class sessions.	90%	69%
Instructor posted material (i.e., pre-recorded lecture and readings) prior to the class and used live class sessions for discussion, questions and active learning activities.	92%	66%
Instructor posted course material for students to view at their own time, without any live class sessions.	88%	50%
Instructor assigned classmates as study buddies.	37%	33%
Instructor assigned students to breakout groups in live class sessions.	84%	28%

The results are arranged in the descending order of the percentage for "Helpful or Very Helpful."
1 The percentage out of the total respondents to each question item.
2 The percentage out of the total respondents who provided a rating for helpfulness.

Perceptions of Online Learning

Helpful Learning Activities

Students were asked what activities helped them learn in the online environment. As shown in Table 1.2, over four-fifths of the respondents worked with friends outside of class and found this experience to be helpful or very helpful to their learning. In addition, 70% of the respondents found being part of a social media group and being in a mentorship relationship to be helpful or very helpful to their learning.

Table 1.2. Ratings for Learning Activities

Learning Activities	Applicable[1]	Helpful or Very Helpful[2]
Working with friends outside of class	85%	83%
Participating in a social media group	76%	70%
Forming a mentorship relationship with another student, a TA or an instructor	49%	70%
Working with assigned classmates outside of class	74%	60%
Working on a team project outside of class	83%	58%
Using resources to develop online learning skills	59%	56%
Participating in an online student club	49%	48%
Attending student orientation sessions at the start of the term	53%	42%

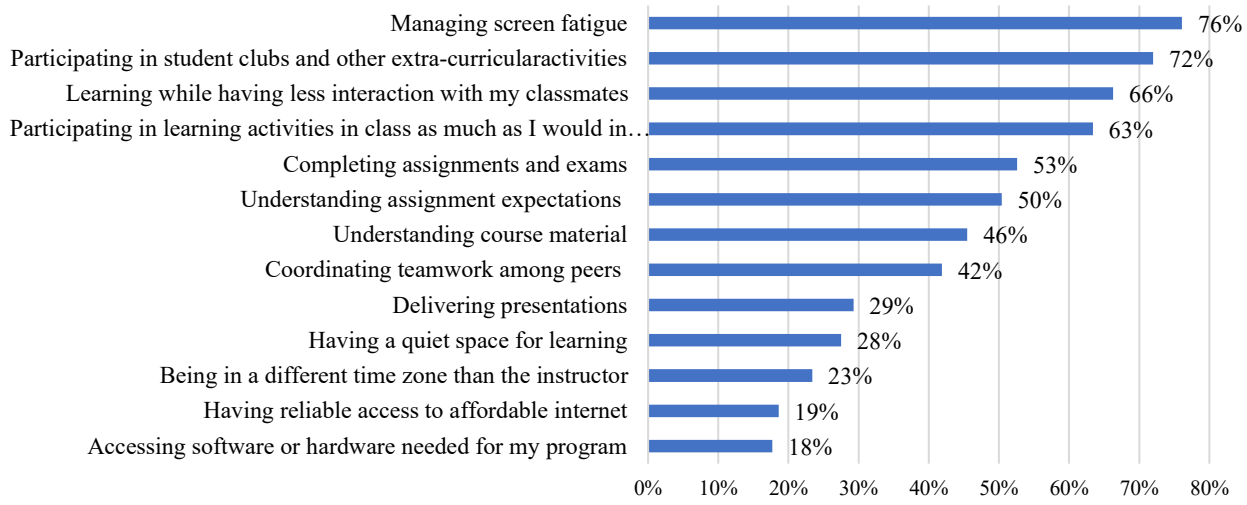
The results are arranged in the descending order of the percentage for "Helpful or Very Helpful."
1 The percentage out of the total respondents to each question item.
2 The percentage out of the total respondents who provided a rating for helpfulness.

Challenges Encountered

Students were asked to evaluate the level of challenge they experienced with various areas related to their online learning. As shown in Figure 1.2, slightly over three-quarters of the respondents reported managing screen fatigue as a substantial challenge; and two-thirds or more reported participating in student clubs and other extra-curricular activities, and learning while having less interaction with classmates to be a substantial challenge. In comparison, students experienced much lower level of challenge in delivering presentations (29% indicating Quite a Challenge or A Huge Challenge).

In addition, a small (18-27%) but significant proportion of the respondents indicated aspects related to access to online learning as a substantial challenge (i.e., the four items at the bottom of Figure 1.2).

Figure 1.2. Perceptions of Experienced Challenges:
Ratings of "Quite a Challenge" and "A Huge Challenge" for various learning experiences



Students were asked to indicate to what extent they agreed or disagreed with a set of statements on various aspects of their online learning. The ratings of "Agree or Strongly Agree" in Table 1.3 suggest

- The vast majority of the respondents (81%) perceived a higher academic workload in online learning than taking classes in person.
- Over nine out of ten students studied most of the course materials while nearly eight out of ten attended most of the classes this term. The vast majority of students (84%) adjusted their learning strategies when learning online.
- While students had good reasons for feeling motivated for learning—having interest in courses (84%) and recognizing the value of the courses (90%), most of them did not enjoy online learning (61%) and felt less motivated to learn in the online environment (79%).
- The vast majority of students felt support from instructors and peers. However, a slightly higher proportion of the respondents felt supported by peers (90%) than by instructors (80%).

Table 1.3. Ratings of Agreement with a List of Statements on Online Learning

Statements	Agree or Strongly Agree
Workload	
My course-related workload was higher online than when I took classes in person.	81%
Academic Engagement	
I attended most of the classes this term.	79%
I studied most of the course materials (e.g., lecture videos, slides and readings) this term.	92%
I used different strategies to learn online than I would in person	84%
It was easier and safer to ask questions in an online learning environment.	50%
Motivation for Learning	
The courses I took this term were interesting.	84%
Courses I took this term will be useful to my future studies or development.	90%
I enjoyed online learning this term.	39%
I was less motivated to learn in an online environment than when I took courses in person.	79%
Support	
My peers were supportive.	90%
My instructors were supportive.	80%
Overall	
Assessment methods used in most of my courses allowed me to demonstrate my learning.	62%
Online instruction provided the same quality of education as in-person instruction.	24%

Learning Strategies

Table 1.4 shows that around half of the respondents felt a negative impact of the online learning environment on their abilities to manage time, persevere and seek help. In addition, when asked how often they used a list of learning strategies during the term, the respondents indicated that they were still able to persist in their studies, despite the adverse conditions, but they were less able to mange their time well (Table 1.5).

Table 1.4. Impact Ratings of the Online Learning Environment

	Somewhat or Significantly Negatively Affected	Not affected	Somewhat or Significantly Positively Affected
Time management	55.9%	10.2%	33.9%
Ability to persevere	47.7%	23.5%	28.8%
Help seeking	45.1%	21.6%	33.3%
Goal setting	37.4%	39.1%	23.5%

Table 1.5. Level of Engagement with Learning Strategies

Learning Strategies	Often or Very Often
Persistence	
I work very hard to do well in my studies, even when I don't like all the tasks or the material I am reading.	79.2%
Help-seeking	
I seek help from my fellow students or instructors if I have difficulties understanding something.	67.2%
Self-Management	
After a study assignment I think about how I did and how I could improve my performance.	62.9%
Before a study assignment, I review its different steps in my mind.	53.5%
I set learning goals to focus my studies.	50.4%
Time Management	
I use the time that I have reserved for studying efficiently.	45.9%
I follow a defined timetable when I'm studying.	39.8%
Even in a tough situation I stick to the schedule I have made for myself.	34.1%

Perceptions of the Fall Study Break

Most of the respondents expressed positive views about the Fall Study Break (i.e., the week of November 9-13, 2020), as shown in Table 1.6.

Table 1.6. Ratings for the Fall Study Break

Benefits	Agree or Strongly Agree
Reduced my level of stress	89.0%
Helped me catch up on my course work	88.6%
Made learning more enjoyable	81.9%
Improved my understanding of the course material	78.5%
Increased my motivation to learn	77.9%
Increased my interest in the course material	63.4%

Perceptions of Mental Health

Figure 1.3 shows that although three-quarters of the respondents described their mental health before the pandemic as good or above, nearly 70% indicated that their mental health became somewhat or much worse when taking courses online in comparison with in-person course delivery.

Figure 1.3a. In general, how would you describe your mental health BEFORE the pandemic? (n=512)

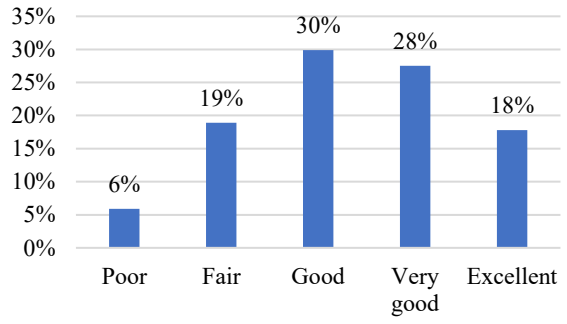
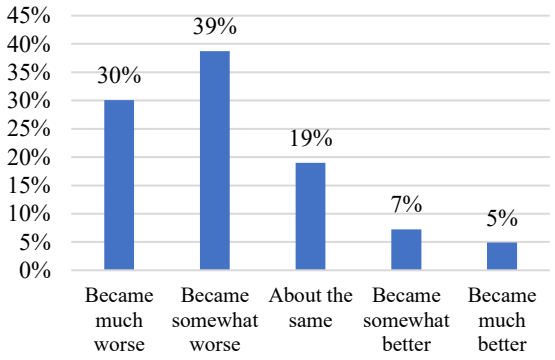


Figure 1.3b. How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (n=511)



Learning Outcomes[2]

Students were asked how much their experience this term contributed to their knowledge, skills and personal development. Table 1.7 shows that the top four areas of competency development as perceived by engineering students were information analysis (55%), critical thinking (54%), applications in engineering practice (48%) and teamwork (46%) while the speaking ability appeared to be the least developed competency (23%).

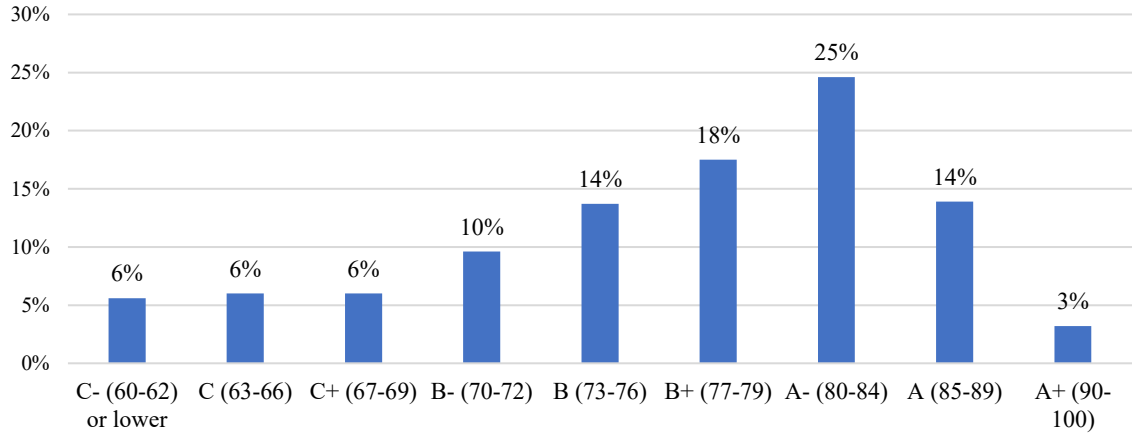
When asked about their estimated grades for this term, 75% of the respondents indicated B or above, as shown in Figure 1.4.

[2] A comparison needs to be made between these results and the data collected before the pandemic in order to better understand how well students were performing in the online environment in terms of competency development.

Table 1.7. Ratings for Competency Development

Competencies[3]	Quite a Bit or Very Much
Analyzing numerical and statistical information	55%
Thinking critically and analytically	54%
Applying appropriate techniques and tools to engineering practice	48%
Working effectively with others	46%
Solving complex real-world problems	45%
Developing or clarifying a personal code of values and ethics	41%
Writing clearly and effectively	38%
Understanding people of other backgrounds (economic, racial/ethnic, political, religious, nationality, etc.)	32%
Acquiring job- or work-related knowledge and skills	32%
Being an informed and active citizen	29%
Speaking clearly and effectively	23%

Figure 1.4. Estimated grades for this term (n=468)



(Mean = 5.59, SD = 2.08, when these grades are on a scale from 1-9)

[3] These items except "Applying appropriate techniques and tools to engineering practice" were used with permission from *The College Student Report*, National Survey of Student Engagement, Copyright 2001-19 The Trustees of Indiana University.

Background Information of the Respondents

The survey respondents came from all engineering programs of FASE and studied in all years. Almost all of the respondents (98%) were studying on a full-time basis. Slightly over four-fifths (81%) took 5 or 6 courses during the term; and 75% of the respondents were located in Toronto.

Figure 1.5. Number of courses taken in Fall Term, 2020 (n=649)

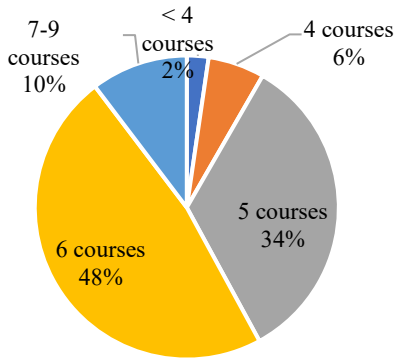


Figure 1.6. Current Program of Study (n=658)

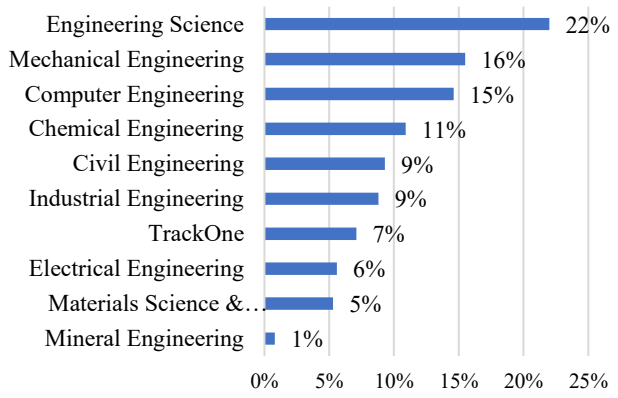


Figure 1.7. Current Year of Study (n=659)

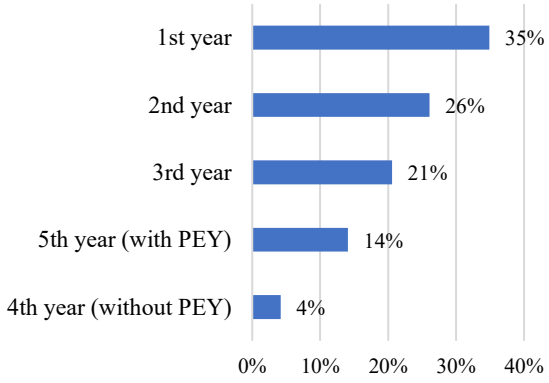
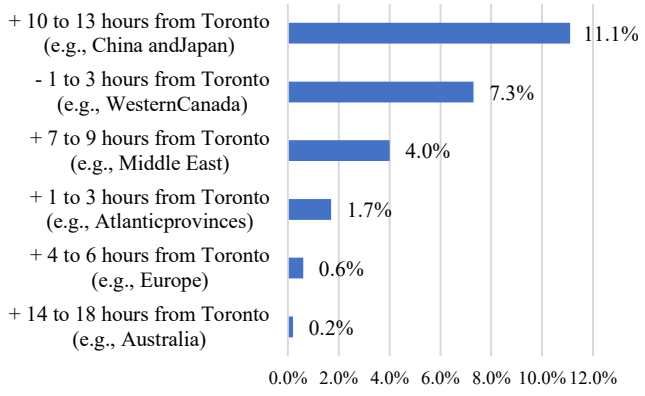


Figure 1.8. Where Else Students Were Located in Fall Term, 2020 (n=657)



Women constituted nearly half of the total respondents, thus over-representing the student population. The top three racial groups of the respondents were White, Chinese and South Asians. Nearly one-fifth (19%) of the respondents who indicated their sexual orientation identified themselves with LGBTQ. Nearly one-tenth (9%) registered with Accessibility Services.

Figure 1.9. Gender of Respondents (n=440)

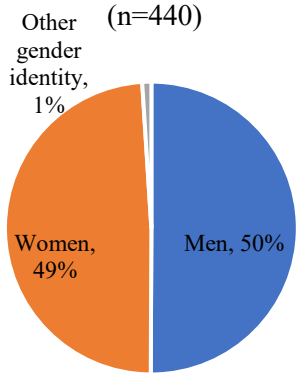


Figure 1.10. Residential Status of Respondents (n=446)

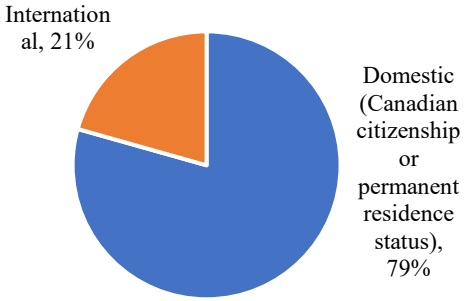


Table 1.8. Racial Identity of Respondents

Race / ethnicity	n	%
Chinese	122	28%
White	118	27%
South Asian (Indian, Pakistani, Sri Lankan, East Indian from Guyana, etc.)	67	15%
Middle Eastern	23	5%
East Asian, excluding Chinese(Japanese, Korean, etc.)	20	5%
Black (African, Caribbean, Canadian, etc.)	15	3%
Latino /Latina / Latinx /Hispanic	7	2%
Southeast Asian (Cambodian, Filipino, Indonesian, Laotian, Vietnamese, Thai, etc.)	5	1%
West Asian (Iranian, Iraqi, Persian, etc.)	4	1%
First Nations	1	0%
More than one racial/ethnic identity provided	53	12%
Total	435	100%

Table 1.9. Sexual Orientation of Respondents

	n	%
Heterosexual/Straight	331	81.3%
Bisexual	42	10.3%
Lesbian	15	3.7%
Asexual/Non-sexual	10	2.5%
Gay	6	1.5%
Pansexual	3	0.7%

Table 1.10. Are you registered with Accessibility Services to receive academic accommodation in 2020?

	n	%
Yes	41	9.2%
No	382	85.7%
Unsure	23	5.2%

Section 2. Perceptions of Academic Workload: Results from the December 2020 Survey[4]

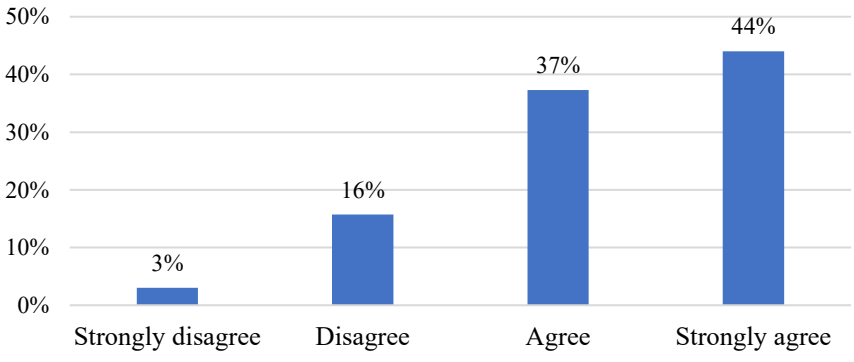
Data source: FASE Undergraduate Student Survey on Online Learning, administered from December 10, 2020 to January 18, 2021. A total of 503 students completed the survey, with a response rate of 10.4%; and another 156 students responded to some of the questions. This report presents the quantitative and qualitative results on perceived academic workload from the responses of all these students.

Findings: Our quantitative and qualitative data analysis revealed the following six findings about engineering students' perception of their academic workload in the current online learning environment.

1. Approximately 80% of the students perceived a higher academic workload when learning online than taking classes in person.
2. Three student-level factors were found to be significantly associated with the perception of increased workload. Students who (a) had lower motivation for learning, (b) had higher abilities to self-regulate and (c) had no quiet space to study were more likely to perceive an increased workload when learning online.
3. Certain course delivery and assessment methods and the general lack of social interactions in the online environment were two factors that affected students' perception of increased workload.
4. Excessive workload affected students' mental health.
5. The perception of increased workload was negatively associated with student learning.
6. Students tried to apply time management techniques to manage their workload.
7. The major concern students had about the Fall Break Week was related to heavy workload.

Finding 1: The vast majority of the respondents[5] (81%) perceived a higher academic workload in online learning than taking classes in person (Figure 2.1).

Figure 2.1. My course-related workload was higher online than when I took classes in person (n=432)



[4] This section was presented to the FASE Taskforce on Academic Workload in February 2020. Juliette Sweeney, a doctoral student in the Collaborative Engineering Education program, and Amy Yu Xuan Huang, a second-year Engineering Science student, assisted with the qualitative data analysis for this section.

[5] A total of 103 students indicated "no opinion" for this question. Seventy-seven percent of these students (n=79) were in their first year of studies.

Finding 2: Three student-level factors were found to be significantly associated with the perception of increased workload. Students who (a) had lower motivation for learning, (b) had higher abilities to self-regulate and (c) had no quiet space to study were more likely to perceive an increased workload in the current online learning environment.

As shown in Table 2.1, there was a negative association between the Motivation Score[6] and the perception of increased workload, with an odds ratio of .27. This means that as students' motivation for learning increased, they were less likely to perceive increased workload; specifically, for every one-unit increase on the Motivation Score, the odds of perceiving increased workload changed by a factor of .27, which means the odds are decreasing. Conversely, every one-unit increase in students' self-regulation score[7] was associated with the increased odds of perceiving increased workload by a factor of 1.95 (i.e., almost 2); in other words, those students who were better at self-regulated learning were more likely to feel an increase in their academic workload. This might be because the process they used to regulate their learning prolonged the time to complete academic tasks, thus making them feel an increase in academic workload.

Table 2.1. Results from binary logistic regression on perceived workload

	B	S.E.	Odds Ratio
Constant	2.64	0.90	14.07
Motivation	-1.32***	0.24	**0.27**
Time management	0.03	0.21	1.03
Self-regulation	0.67**	0.21	**1.95**
Help seeking	0.15	0.17	1.16
Persistence	0.06	0.18	1.06
Gender: Women (vs. Men)	-0.36	0.27	0.70
Gender: Other identity/Unknown (vs. Men)	0.77	0.85	2.16
International students (vs. Domestic)	0.51	0.38	1.66
Residential status: Unknown (vs. Domestic)	0.45	0.94	1.56
Year of study: 1st year (vs. 3rd year)	0.52	0.39	1.69
Year of study: 2nd year (vs. 3rd year)	0.03	0.37	1.03
Year of study: 4-5th year (vs. 3rd year)	0.19	0.41	1.21

***p < .001; ** p < .01.

Lack of motivation for online learning may have precipitated the perception of increased workload and the perception of increased workload may have also negatively affected student motivation. Table 2.1 shows that the majority of students did not enjoy online learning and felt less motivated to learn in the

[6] The Motivation Score was derived from averaging the responses to four survey items, which had a good internal consistency, with the Cronbach's alpha of .70. These survey question items were "The courses I took this term were interesting"; "I enjoyed online learning this term"; "Courses I took this term will be useful to my future studies or development"; and "I was less motivated to learn in an online environment that when I took courses in person" (the reversed scale was used).

[7] The self-regulation score was derived from averaging the responses to three survey items, with the Cronbach's alpha of .67. These survey question items were "Before a study assignment, I review its different steps in my mind"; "I set learning goals to focus my studies"; and "After a study assignment I think about how I did and how I could improve my performance."

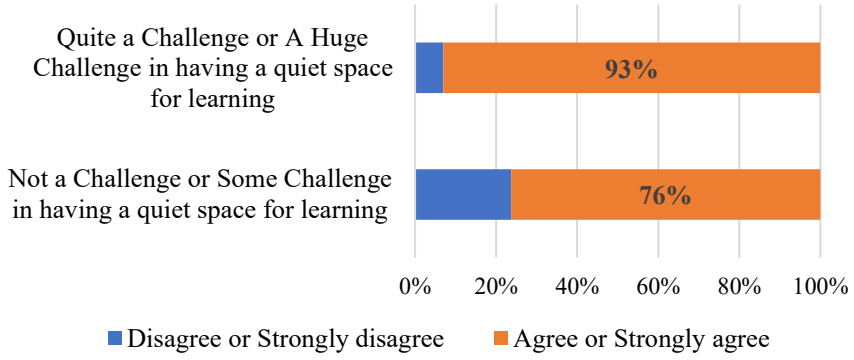
online environment (61% and 79% respectively) although they mostly had interest in, and recognized the value of, the courses they took. This suggests that lack of motivation for learning in the current online environment appears to be a barrier to a positive perception of academic workload.

Table 2.1. Results on motivation for learning and self-regulation

Motivation for Learning: To what extent do you agree or disagree with the following statements?	Agree or Strongly Agree
The courses I took this term were interesting.	84%
Courses I took this term will be useful to my future studies or development.	90%
I enjoyed online learning this term.	39%
I was less motivated to learn in an online environment than when I took courses in person.	79%
Self-Regulation: How often have you done the following this term?	Often or Very Often
After a study assignment I think about how I did and how I could improve my performance.	63%
Before a study assignment, I review its different steps in my mind.	54%
I set learning goals to focus my studies.	50%

A third student-level factor that affected a small proportion of students was having a quiet space at home. Those students who indicated a substantial challenge in having a quiet space at home were more likely to perceive an increased workload (Figure 2.2).

Figure 2.2. My course-related workload was higher online than when I took classes in person (n=428)



Finding 3: Qualitative results showed that certain course delivery and assessment methods and the general lack of social interactions in the online environment appeared to have affected students' perception of increased workload.

A total of 58 respondents[8] voluntarily provided 77 comments that explicitly addressed their perceptions of the academic workload in the fall term in response to seven open-ended questions in the survey. Some

[8] These students were from all years of studies. A slightly higher proportion of these students than the total survey respondents were registered with the University's Accessibility Services to receive academic accommodation (12% versus 9%) and international students (27% versus 21%).

student comments suggested that use of recordings, mini-assignments and lack of formative feedback in the online environment resulted in the perception of an increased workload.

> *For some courses, the increased amount of workload was detrimental to learning. There were too many "mini" assignments throughout the month which did not aid in learning retention.* (#588, 5th-year student with PEY)

> *Watching videos outside of class times is not helpful it consumes the student's time to study and do homework/assignments. I had to watch 6+ hours of videos for one class outside of class time which caused me to fall behind in other courses since watching the videos were necessary.* (#728, 3rd-year student)

> *Professor's using pre-recorded lectures usually went over time and it increased the workload significantly. Some pre-recorded lectures were sped up to 1.5x (maybe even 2x) and lasted an hour which in reality takes over 3 hours to complete.* (#75, 3rd-year student)

> *felt like we just thrown a textbook and some videos and told to teach ourselves… we didn't really get any feedback on if we understood a concept correctly or not, until a major assessment, at which point not only do our marks(and self esteem) drop, but the amount of re-learning that needs to be done becomes quickly overwhelming… Please give us more chances for feedback that aren't necessarily mark based!* (#158, 1st-year student)

Other comments revealed that perceived academic workload was also ascribed to the general lack of social interactions in the process of online teaching and learning.

> *I live alone and have little access to contact with too many people. The intensive workload and many unreasonable aspects due to the online shift severely negatively impacted and isolated me, keeping me stuck too my desk for weeks at a time.* (#240, 2nd-year student)

> *It is definitely harder to seek help since TAs and Prof are only available through email or office hours so it is hard to get one-one time to ask questions or to get urgent replies.* (#742, 2nd-year student)

Finding 4: Excessive workload affected students' mental health.

Figure 2.2 shows that although three-fourths of the respondents described their mental health before the pandemic as good or above, nearly 70% indicated that their mental health became somewhat or much worse when taking courses online in comparison with in-person course delivery.

Figure 2.2a. In general, how would you describe your mental health BEFORE the pandemic? (n=512)

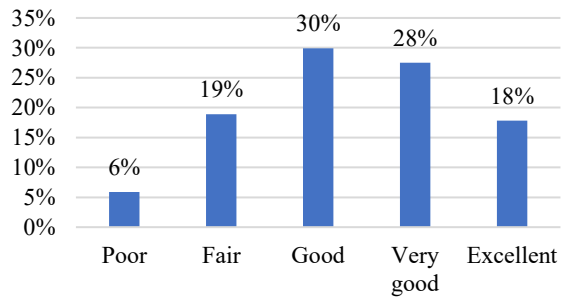
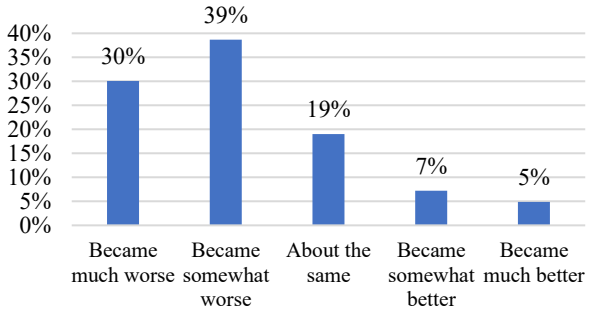


Figure 2.2b. How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (n=511)



The qualitative data revealed that excessive workload affected students' physical and mental health, as illustrated below. The quantitative results showed a moderate, positive association between the perception of increased workload and deteriorated mental health, $r_s = .385$, $p < .001$.

> *Too much stress. Huge workload. No time to rest. I want to sleep.* (#66, first-year student)
>
> *The workload was overbearing and I felt like I was drowning in it* (#394, second-year student)
>
> *Weeks with too many due dates, being overwhelmed by course work and assignments, feeling alone, not having friends or adults to talk to.* (#570, first-year student)

Finding 5. The perception of increased workload was negatively associated with student learning.

Quantitative data showed a negative correlation between the perception of increased workload for online learning and the perception of skill development, with r_s being -.15 for "thinking critically and analytically" ($p < .01$), -.10 for "analyzing numerical and statistical information" ($p < .05$), -.11 for "acquiring job- or work-related knowledge and skills" ($p < .05$), and -.12 for "solving complex real-world problems" ($p < .05$). The correlation between students' perception of increased workload and their estimated grades was also negative, $r_s = -.16$, $p < .01$.

Student comments suggested that the excessive workload, accompanied with the stress during the pandemic, affected students' abilities to take a deep approach to learning, as illustrated below.

> *Also being at home and dealing with all the stress of the world in addition to the extra workload of school makes it hard to persevere, instead you just go into survival mode and just hope to pass. This semester was barely manageable because professors expected more from us compared to in-person learning (time commitment and number of resources we were expected to use to learn the material - to replace a 50 min lecture).* (#539, 3rd-year student)

Finding 6. Students tried to apply time management techniques to manage their workload.

Qualitative data suggested that increased workload stretched students' time management skills and some students were able to cope with the workload challenge by improving their skills in managing their time better.

> *Online learning has forced me to manage my time better and I have been using my resources (like my professors and TAs) more often to ask questions with online learning. It has been extremely hard and the workload is incredibly more than last year, but it has taught me a lot about how strong I am.* (#89, 3rd-year student)
>
> *Due to the increased workload I was forced to improve my time management skills.* (#711, 2nd-year student)

Finding 7. While the vast majority of students (89%) found the Fall Study Break beneficial to reducing their level of stress, the major concern students had about the break week was related to heavy workload.

Student comments suggested three reasons for which that the Fall Study Break did not help them deal with the heavy workload. A frequent comment was that the workload before and/or after the week was too heavy. Some students also raised the concern that instead of 13 weeks of the study period, the Study Break forced instructors to compress all course content in 12 weeks, resulting a faster pace and heavier workload than the semester without a Study Break. Other students pointed out that some course instructors still assigned course work to students during the Study Break. Below are two illustrating comments.

> *I felt as if my assignment and test deadlines were heavily concentrated before and after the reading week. And some professors were having trouble finishing all the course content on time. I would rather have a "deadline-free" week in which we would still have lectures, but no tests, labs, or assignment deadlines.* (#188, 3rd-year student)

> *I loved having the time to catch up on my classes but I found because of it all of our assignments got pushed to the week finals started which made that time more stressful.* (#896, 4th-year students without PEY)

Section 3. Comparison of May and December 2020 Survey Results: A Quantitative Analysis

This section presents the results from comparisons of the quantitative data collected in the May and December 2020 from the Faculty of Applied Science & Engineering (FASE) Undergraduate Student Surveys on Online Learning.

The May 2020 survey was administered to all the undergraduate engineering students who took courses during the Winter Term (January-April) in 2020. A total of 801 undergraduate engineering students responded to the survey, with a response rate of 22%, The December 2020 survey was administered to all the undergraduate engineering students who took courses in the Fall Term (September-December) in 2020. A total of 503 students completed the survey, with a response rate of 10.4%; and another 156 students responded to some of the questions.

The contexts for online learning were different at these two time points of data collection. The May 2020 survey focussed on student experiences during the rapid transition to emergency online teaching and learning that started on March 16th, 2020 and lasted for the rest of Winter Term 2020. In comparison, the December 2020 survey focussed on student experiences during the Fall Term when all courses were delivered entirely online after planning and preparation over the summer.

Statistical comparisons[9] were made on the background and demographic information of the two student samples, and the ratings for the common questions on perceptions of teaching practice, online learning experiences, and mental health. These comparisons revealed the following main findings:

- The two student samples were similar by program and year of study, gender and residential status. However, students appeared to have a higher actual workload (as indicated by the number of courses taken) in the Fall Term 2020 than in the Winter Term 2020.
- Overall, there was not much change in students' perceptions of the online teaching and learning activities from May to December 2020; and the largest change was an increase in perceived academic workload (Figure 3.11).
- Changes in student perceptions of online experiences from May to December varied by program; and so did the extent of the differences. However, perceptions of an increase in academic workload (with a large effect size) and deteriorated mental health (with a medium effect size) occurred across most or all of the programs (Tables 3.1 to 3.9).

It should be noted that there are various reasons that could account for the different ratings in common question items between May and December 2020. These reasons include changed online instructional and assessment practices, online fatigue experienced by many students during the pandemic, or simply different student samples for the two surveys.

[9] Mann-Whitney U test was used to detect any statistically significant differences between the ratings in May and December 2020. The estimate d was used to indicate the effect size. The standard interpretation of d is that .20 represents a small effect, .50 a medium effect, and .80 a large effect when the proportions of participants in the two groups are equal, according to MeGrath and Meyer (2006). (McGrath, R. E., & Meyer, G. J. (2006). When effect sizes disagree: The case of r and d. *Psychological Methods, 11*, 386–401.)

Student Samples

In terms of academic background, the December survey respondents, on average, took more courses than the May survey respondents, with Mean = 5.58, SD = .99 in fall term versus Mean = 5.27, SD = .81 in winter term, $t(1293) = 6.25$, $p < .001$, $d = .34$. In particular, 46% and 9% of the respondents in December 2020 reported having taken 6 and 7 courses respectively, in comparison to 38% and 2% reported by the respondents in May 2020. No statistically significant differences were found in program and year of study between the two samples.

A higher proportion of the respondents to the December survey than those to the May survey (25% versus 15%) reported being physically located in other time zones than Toronto, $X^2(6, N=1302) = 22.51$, $p < .01$. In particular, 11% versus 6% of the respondents to the December and May surveys were located in time zones that were 10 to 13 hours relative to Toronto, that is, in East Asian countries such as China and Japan.

No statistically significant differences were found between the two samples in the distribution by gender or residential status; yet, the December respondents included a higher proportion of self-identified LGBTQ students than the May respondents (19% versus 13%), $X^2(6, N=1002) = 16.33$, $p < .05$.

Perceptions of Teaching Practice

Students' helpfulness ratings for the following teaching techniques *improved* in December 2020, in comparison with spring 2020, with small effect sizes.

- Instructor posted material (i.e., pre-recorded lecture and readings) prior to the class and used live class sessions for discussion, questions and active learning activities, $U = 150182$, $p < .01$, $d = .20$.
- Instructor had live office hours, $U = 114661$, $p < .001$, $d = .30$.

Figure 3.1. Instructor posted material prior to the class and used live class sessions fordiscussion, questions and active learning activities.

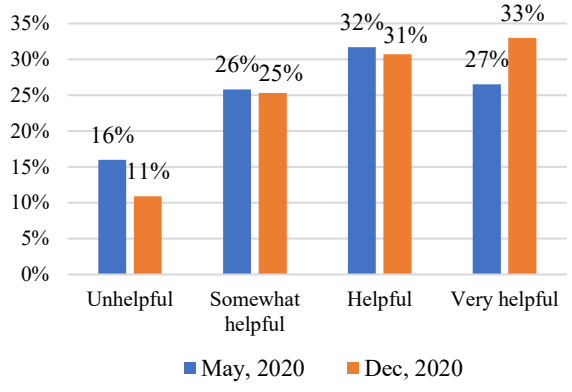
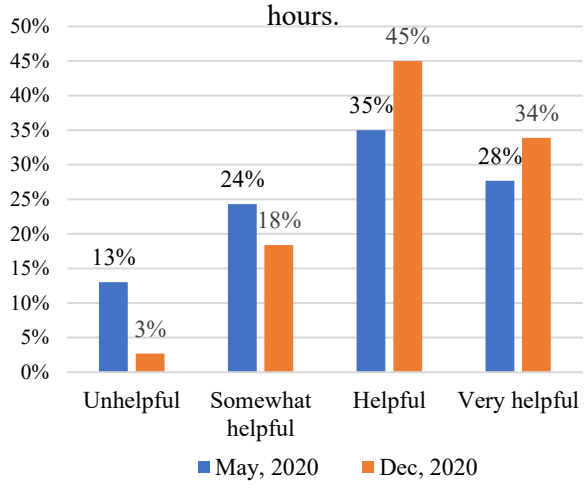


Figure 3.2. Instructor had live office hours.



Students' ratings for the following teaching techniques were better in spring 2020 than those in December 2020, with very small effect sizes.

- Instructor recorded live class sessions and then posted them for student use at their discretion, $U = 215507.5$, $p < .05$, $d = -.13$.
- Instructor assigned students to breakout groups in live class sessions, $U = 103270$, $p < .05$, $d = -.17$.

Figure 3.3. Instructor recorded live class sessions and then postedthem for student use at their discretion.

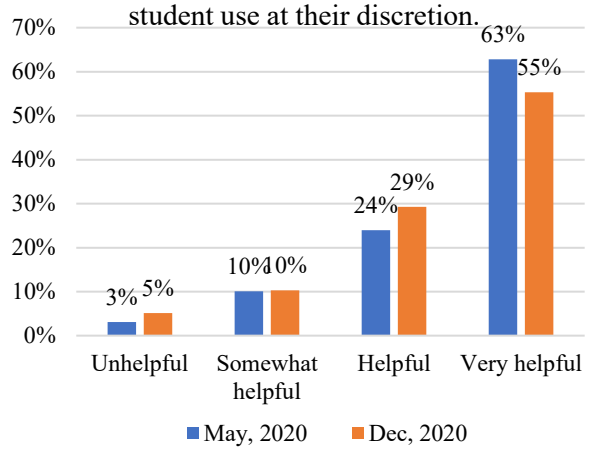
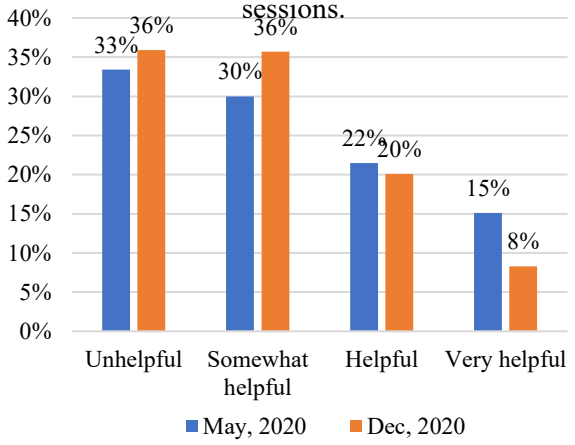


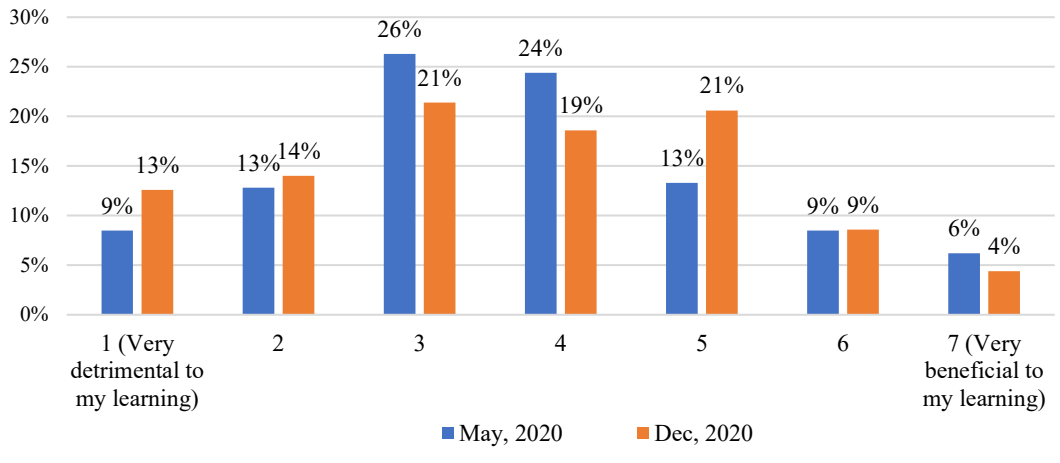
Figure 3.4. Instructor assigned students to breakout groups in liveclass sessions.



No statistically significant differences were found in student perceptions of the following two statements.

- Assessment methods used in most of my courses allowed me to demonstrate my learning, $U = 188541.5$, $p = .23$.
- Overall perceptions about online instruction, $U = 200676.5$, $p = .51$.

Figure 3.5. Overall, I found that the online instruction this term was ...



Perceptions of Challenge in Online Learning

Perceived challenge increased in the following areas from May to December 2020, with perceived academic workload showing the largest effect.

- Understanding course material, $U = 198844$, $p < .001$, $d = .18$ (small effect);
- Being in a different time zone than the instructor, $U = 99826$, $p < .01$, $d = .27$ (small effect);
- Learning while having less interaction with my classmates, $U = 184377.5$, $p < .001$, $d = .28$ (small effect);
- Participating in learning activities in class as much as I would in person, $U = 177222.5$, $p < .001$, $d = .29$ (small effect);
- Feeling less motivated to learn in an online environment than when I took courses in person, $U = 186591$, $p < .05$, $d = .14$ (small effect);
- Perceiving a higher academic workload in the online environment than in person, $U = 94958.5$, $p < .001$, $d = .80$ (large effect).

Figure 3.6. Understanding course material

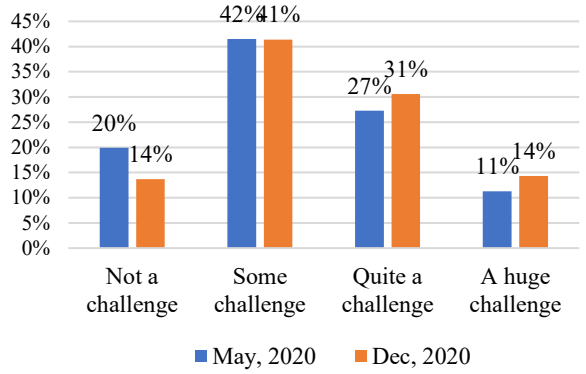


Figure 3.7. Being in a different time zone than the instructor

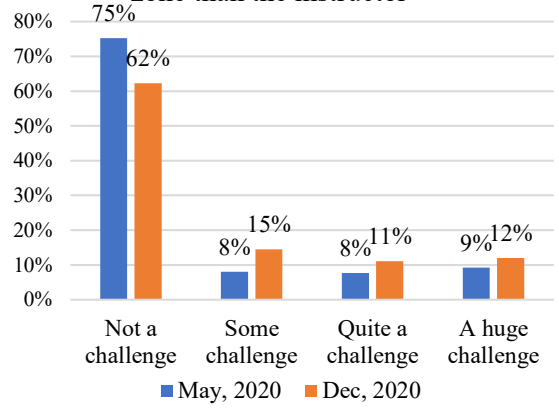


Figure 3.8. Learning while having less interaction with my classmates

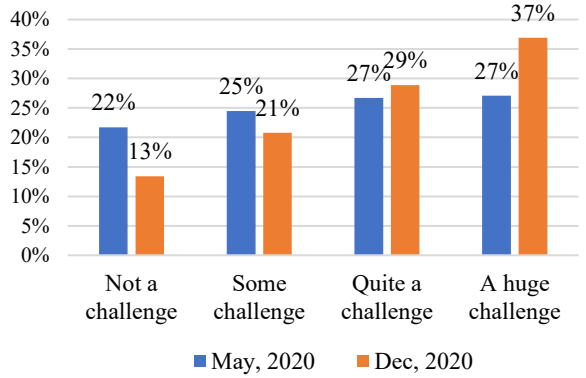


Figure 3.9. Participating in learning activities in class as much as I would in person

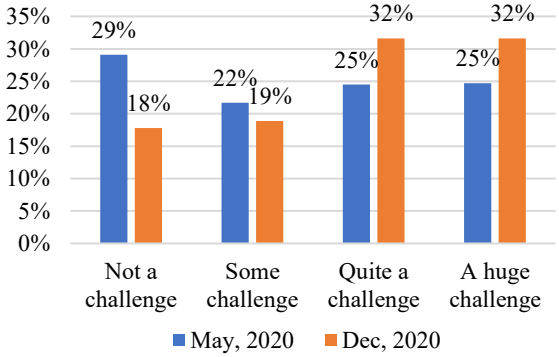


Figure 3.10. I was less motivated to learn in an online environmentthan when I took courses in person.

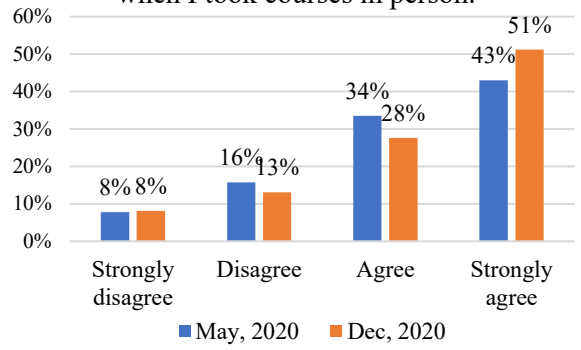
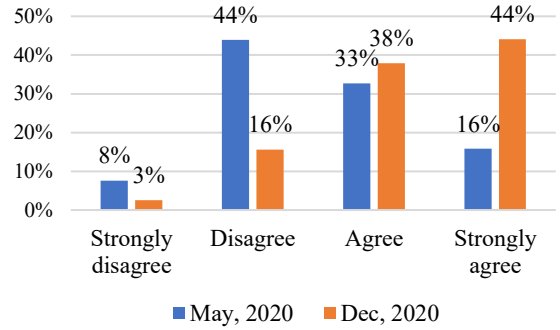


Figure 3.11. My course-related workload was higher online than when Itook classes in person.



Perceived challenge in the following areas *decreased* from spring to December 2020, with small effect sizes.

- Delivering presentations, $U = 89027.5$, $p < .001$, $d = -.27$;
- Coordinating teamwork among peers (including team projects), $U = 178400$, $p < .05$, $d = -.12$.

Figure 3.12. Delivering presentations

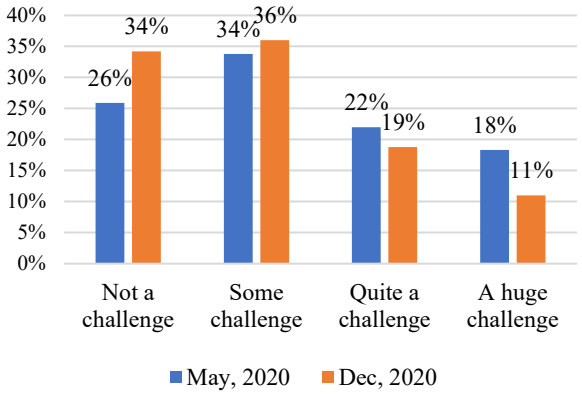
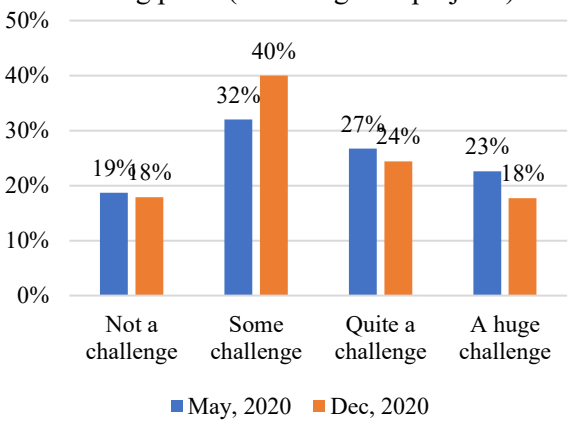


Figure 3.13. Coordinating teamwork among peers (including teamprojects)

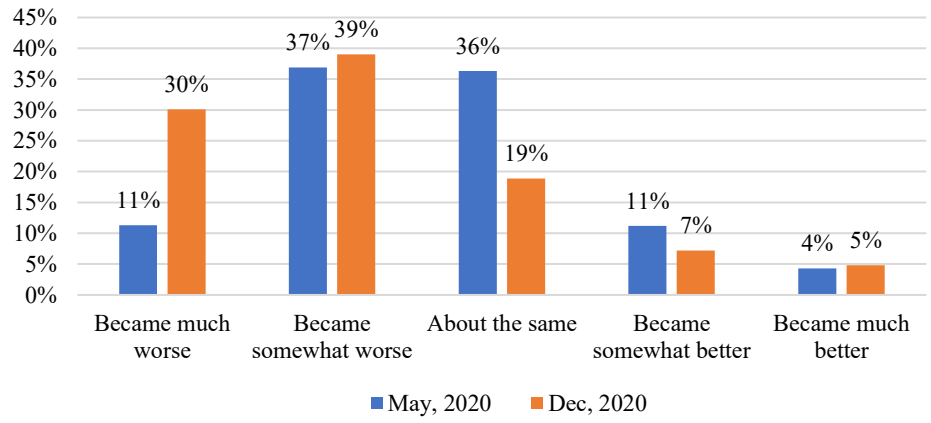


In December 2020, a slightly lower proportion of the respondents found it easier and safer to ask questions in the online environment, as compared to spring 2020, $U = 154948.5$, $p < .01$, $d = .14$ (small effect).

Perception of Mental Health

Respondents' ratings for changes in mental health suggested a deteriorating situation from May to December 2020, $U = 151143$, $p < .001$, $d = -.48$ (medium effect). In particular, a higher proportion of the respondents in December than in May (30% versus 11%) reported that their mental health became much worse in comparison with in-person course delivery.

Figure 3.14. How would you say your mental health changed when taking courses online in comparison with in-person coursedelivery?



Variations by Program

Variations by engineering programs were found between the ratings for the comparable questions in May and December surveys. Overall, changes in student perceptions of online teaching and learning activities from May to December varied by program; and so did the extent of the differences, as measured by the effect size estimate *d*. However, from May to December, students across all programs reported a perceived increase in academic workload, with a large effect size; and the perceived mental health of students from most of the programs appeared to have deteriorated, with a medium effect size except for TrackOne (a large effect size).

The survey items with statistically significant changes in student perceptions in nine of the ten engineering programs are reported in Tables 3.1 to 3.9.[10] In these tables, mean rank values[11] were used to compare the ratings in two points in time, and *d* was used as the effect size estimate.[12]

Table 3.10 presents a summary of these comparisons across programs, which generally reveals that there were more palpable changes on the program level than those on the Faculty level between May and December 2020 in student perceptions of the teaching and learning experiences examined in the surveys.

[10] This comparison analysis was not conducted for Mineral Engineering due to the inadequate sample size.
[11] Interpretation of mean rank comparisons: For example, when a mean rank in December is higher than in May, it means that on average, the ratings in December have a greater chance to be a higher point of the scale than those in May.
[12] Interpretation of d: a small effect = .20; a medium effect = .50; a large effect = .80. In this document, positive effect sizes (d values) are used to indicate an increase between May and December survey results while negative values are used to indicate a decrease.

Table 3.1. Significant differences between May and December, 2020: **TrackOne**

	Mean Rank Comparison	U	d
Perceptions of Teaching Practice			
[Perceived helpfulness] Instructor assigned students to breakout groups in live class sessions..	May > Dec	230.5**	-.78
Assessment methods used in most of my courses allowed me to demonstrate my learning. (1=Strongly disagree; 4=Strongly agree)	May > Dec	680*	-.45
Perceptions of Online Learning			
[Perceived challenge] Understanding course material	May < Dec	566**	.76
[Perceived challenge] Participating in learning activities in class as much as I would in person	May < Dec	659.5*	.55
[Perceived challenge] Learning while having less interaction with my classmates	May < Dec	571.5**	.77
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	186***	1.49
It was easier and safer to ask questions in an online learning environment. (1=Strongly disagree; 4=Strongly agree)	May > Dec	384.5**	-.86
Perception of Mental Health			
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse; 5=Became much better)	May > Dec[1]	480***	-.95

*p < .05; **p < .01; ***p < .001

Positive effect sizes (d values) are used to indicate an increase between May and December survey results while negative values are used to indicate a decrease.

1. This means that students' perception about their mental health was on average better in May than in December 2020; in other words, they felt their mental health was getting worse from May to December.

Table 3.2. Significant differences between May and December, 2020: **Chemical Engineering**

	Mean Rank Comparison	U	d
Perceptions of Online Learning			
[Perceived challenge] Being in a different time zone than the instructor	May < Dec	1126*	.40
[Perceived challenge] Delivering presentations	May > Dec	726.5***	-.77
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	936***	1.11
Perception of Mental Health			
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse; 5=Became much better)	May > Dec	2146*	-.37

*p < .05; **p < .01; ***p < .001

Refer to the notes under Table 3.1 for interpretation.

Table 3.3. Significant differences between May and December, 2020: **Civil Engineering**

	Mean Rank Comparison	U	d
Perceptions of Online Learning			
[Perceived challenge] Coordinating teamwork among peers (including team projects)	May > Dec	662.5***	-.77
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	925**	.59

*p < .05; **p < .01; ***p < .001
Refer to the notes under Table 3.1 for interpretation.

Table 3.4. Significant differences between May and December, 2020: **Computer Engineering**

	Mean Rank Comparison	U	d
Perceptions of Teaching Practice			
[Perceived helpfulness] Instructor recorded live class sessions and then posted them for student use at their discretion.	May > Dec	4413*	-.33
[Perceived helpfulness] Instructor posted material (i.e., pre-recorded lecture and readings) prior to the class and used live class sessions for discussion, questions and active learning activities.	May < Dec	2691.5***	.68
[Perceived helpfulness] Instructor assigned students to breakout groups in live class sessions.	May < Dec	1626*	.35
Assessment methods used in most of my courses allowed me to demonstrate my learning. (1=Strongly disagree; 4=Strongly agree)	May < Dec	3435*	.33
Perceptions of Online Learning			
[Perceived challenge] Participating in learning activities in class as much as I would in person	May < Dec	3817.5*	.31
[Perceived challenge] Coordinating teamwork among peers (including team projects)	May > Dec	2989*	-.40
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	2456.5***	.64
Perception of Mental Health			
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse; 5=Became much better)	May > Dec	3523.5**	-.42

*p < .05; **p < .01; ***p < .001
Refer to the notes under Table 3.1 for interpretation.

Table 3.5. Significant differences between May and December, 2020: **Electrical Engineering**

	Mean Rank Comparison	U	d
Perceptions of Teaching Practice			
[Perceived helpfulness] Instructor posted material (i.e., pre-recorded lecture and readings) prior to the class and used live class sessions for discussion, questions and active learning activities.	May > Dec	479.5*	-.50
Perceptions of Online Learning			
[Perceived challenge] Participating in learning activities in class as much as I would in person	May < Dec	643*	.48
[Perceived challenge] Completing assignments and exams	May > Dec	630.5**	-.63

My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	512.5*	.51
Perception of Mental Health			
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse; 5=Became much better)	May > Dec	569.5**	-.63

*p < .05; **p < .01; ***p < .001
Refer to the notes under Table 3.1 for interpretation.

Table 3.6. Significant differences between May and December, 2020: Engineering Science

	Mean Rank Comparison	U	d
Perceptions of Teaching Practice			
[Perceived helpfulness] Instructor had live office hours.	May < Dec	6356.5**	.39
Overall perceptions of online instruction (1=Very detrimental to my learning; 7=Very beneficial to my learning)	May < Dec	9363.5*	.27
Perceptions of Online Learning			
[Perceived challenge] Being in a different time zone than the instructor	May < Dec	5925.5**	.44
[Perceived challenge] Participating in learning activities in class as much as I would in person	May < Dec	8793.5***	.46
[Perceived challenge] Learning while having less interaction with my classmates	May < Dec	10377*	.27
[Perceived challenge] Delivering presentations	May > Dec	5357*	-.29
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	5046.5***	.71
Perception of Mental Health			
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse; 5=Became much better)	May > Dec	7677***	-.58

*p < .05; **p < .01; ***p < .001
Refer to the notes under Table 3.1 for interpretation.

Table 3.7. Significant differences between May and December, 2020: Industrial Engineering

	Mean Rank Comparison	U	d
Perceptions of Teaching Practice			
[Perceived helpfulness] Instructor assigned students to breakout groups in live class sessions.	May > Dec	636.5**	-.69
[Perceived helpfulness] Instructor had live office hours.	May < Dec	751*	.55
Assessment methods used in most of my courses allowed me to demonstrate my learning. (1=Strongly disagree; 4=Strongly agree)	May > Dec	721**	-.58
Perceptions of Online Learning			
[Perceived challenge] Participating in learning activities in class as much as I would in person	May < Dec	938*	.53
[Perceived challenge] Delivering presentations	May > Dec	499**	-.71
[Perceived challenge] Completing assignments and exams	May < Dec	1051.5*	.47
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	619.5*	.52

Perception of Mental Health			
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse; 5=Became much better)	May > Dec	877.5**	-.41

*p < .05; **p < .01; ***p < .001
Refer to the notes under Table 3.1 for interpretation.

Table 3.8. Significant differences between May and December, 2020: **Materials Science & Engineering**

	Mean Rank Comparison	U	d
Perceptions of Teaching Practice			
[Perceived helpfulness] Instructor had live office hours.	May < Dec	202**	.77
Perceptions of Online Learning			
[Perceived challenge] Delivering presentations	May > Dec	284*	-.54
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	221.5***	1.10

*p < .05; **p < .01; ***p < .001
Refer to the notes under Table 3.1 for interpretation.

Table 3.9. Significant differences between May and December, 2020: **Mechanical Engineering**

	Mean Rank Comparison	U	d
Perceptions of Teaching Practice			
Assessment methods used in most of my courses allowed me to demonstrate my learning. (1=Strongly disagree; 4=Strongly agree)	May > Dec	3557*	-.33
Perceptions of Online Learning			
[Perceived challenge] Having a quiet space for learning	May < Dec	3943.5*	.32
[Perceived challenge] Having reliable access to affordable internet	May < Dec	4053*	.31
[Perceived challenge] Learning while having less interaction with my classmates	May < Dec	3411**	.50
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	May < Dec	1815***	1.09
Perception of Mental Health			
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse; 5=Became much better)	May > Dec	3318**	-.43

*p < .05; **p < .01; ***p < .001
Refer to the notes under Table 3.1 for interpretation.

Table 3.10. Summary of program comparisons in survey results between May and December 2020

	TrackOne	Chem	Civil	Comp	Elec	EngS	Indu	MSE	Mech	All
Perceptions of Teaching Practice										
[Perceived helpfulness] Instructor recorded live class sessions and then posted them for student use at their discretion.				-.33						-.13
[Perceived helpfulness] Instructor posted material (i.e., pre-recorded lecture and readings) prior to the class and used live class sessions for discussion, questions and active learning activities.				.68	-.50					.20
[Perceived helpfulness] Instructor assigned students to breakout groups in live class sessions.	-.78			.35			-.69			-.17
[Perceived helpfulness] Instructor had live office hours.						.39	.55	.77		.30
Assessment methods used in most of my courses allowed me to demonstrate my learning. (1=Strongly disagree; 4=Strongly agree)	-.45			.33)			-.58		-.33	
Overall, I found that the online instruction this term was … (1=Very detrimental to learning, 7=Very beneficial to learning)						.27				
Perceptions of Online Learning										
[Perceived challenge] Having a quiet space for learning									.32	
[Perceived challenge] Having reliable access to affordable internet									.31	
[Perceived challenge] Being in a different time zone than the instructor		.40				.44				.27
[Perceived challenge] Understanding course material	.76									.18
[Perceived challenge] Participating in learning activities in class as much as I would in person	.55			.31	.48	.46	.53			.29
[Perceived challenge] Delivering presentations		-.77				-.29	-.71	-.54		-.27

[Perceived challenge] Coordinating teamwork among peers (including team projects)			-.77	-.40						-.12
[Perceived challenge] Learning while having less interaction with my classmates	.77					.27			.50	.28
[Perceived challenge] Completing assignments and exams					-.63		.47			
My course-related workload was higher online than when I took classes in person. (1=Strongly disagree; 4=Strongly agree)	1.49	1.11	.59	.64	.51	.71	.52	1.10	1.09	.80
I was less motivated to learn in an online environment than when I took courses in person. (1=Strongly disagree; 4=Strongly agree)										.14
It was easier and safer to ask questions in an online learning environment. (1=Strongly disagree; 4=Strongly agree)	-.86									-.14
Perception of Mental Health										
How would you say your mental health changed when taking courses online in comparison with in-person course delivery? (1=Became much worse, 5=Became much better)	-.95	-.37		-.42	-.63	-.58	-.41		-.43	-.48

Note: This table reports the effect sizes, Cohen's *d* values, for those survey question items that showed a statistically significant difference between May and December in 2020. Positive effect sizes are used to indicate an increase between May and December survey results while negative values are used to indicate a decrease.

Section 4. Comparison of December 2020 and May 2021 Survey Results

An engineering student survey about online experience during the pandemic was administered online in December 2020 and May 2021 respectively. Most of the survey questions asked by the two questionnaires were the same. A total of 503 students[13] and 189 students[14] completed the December 2020 and May 2021 surveys respectively. As the May 2021 survey[15] mainly targeted the second- and third-year students, comparisons between the surveys were limited to these second- and third-year students. That is, data from 238 respondents to the December 2020 survey and 150 respondents to the May 2021 survey were included in the comparison analysis. Table 4.1 shows the distribution of survey respondents who were included in this analysis.

Table 4.1. Distribution of survey respondents by year of study

	December 2020 survey		May 2021 survey	
Year of Study	n	%	n	%
2nd year	137	58%	87	58%
3rd year	101	42%	63	42%
Total	238	100%	150	100%

The **purpose** of this comparison analysis was to detect whether there was any improvement from the Fall Term to Winter Term over the academic year 2020-21 with respect to engineering students' perceptions of online learning experience during the pandemic.

Results from Chi-square tests showed no statistically significant differences in background characteristics between these respondents to the December 2020 and May 2021 surveys: year of study, program of study, number of courses taken during the term, part-time versus full-time status, time zone of their location for the majority of the term, gender, race, residential status (i.e., international versus domestic student), sexual orientation, and registration with accessibility services. This means that the two groups of respondents had comparable academic and demographic backgrounds.

Data Analysis Method. Mann-Whitney U test was used to detect any statistically significant differences between the ratings for common questions asked in December 2020 and May 2021 surveys. The estimate *d* was used to indicate the effect size. The standard interpretation of *d* is that .20 represents a small effect, .50 a medium effect, and .80 a large effect when the proportions of participants in the two groups are equal.[16]

The majority of the common survey items included for comparison did not show statistically significant differences. The detected improvement between the Fall and Winter terms can be summarized as follows.

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[13] The December survey was administered from December 10, 2020 to January 18, 2021 to all undergraduate engineering students who took courses in the Fall Term 2020. The response rate was 10%.

[14] The May survey was administered from May 3 to 21, 2021 to mainly second- and third-year students who took courses in the Winter Term 2021. The response rate was 7%.

[15] You are welcome to contact us for a copy of the survey instrument.

[16] McGrath, R. E., & Meyer, G. J. (2006). When effect sizes disagree: The case of r and d. *Psychological Methods, 11,* 386–401.

- A higher proportion of students favoured use of the inverted classroom approach (i.e., instructors posted material prior to class and used live class sessions for discussion, questions and active learning activities) and the instructors staying active on the online discussion forum (e.g., Piazza), with a small effect size (d = .28 and .22 respectively). (Figure 4.1)
- A higher proportion of students found working on a team project outside of class very helpful (Figure 4.2a), d = .35 while a decreased proportion of students found learning with less interaction with their peers a substantial challenge, d = -.08. (Figure 4.2b)
- A higher proportion of students strongly agreed that they used different learning strategies when learning online than they would in person; and a higher proportion of students agreed or strongly agreed that online instruction provided the same quality of education as in-person instruction, albeit a very small effect size (d = .10 and .06 respectively).
- Among the 11 competencies asked about in the survey, the only one with a statistically significant difference in perceived gains was speaking communication, d = .26.

More detailed results are presented as below.

Results from Quantitative Data

Teaching techniques: As shown in Figure 4.1, a higher proportion of respondents in the Winter than Fall term (42% vs. 32%) found the inverted classroom approach very helpful, Mann-Whitney U = 12580.5, p = .01. d = .28. In addition, an increased proportion of respondents indicated that it was very helpful when an "instructor stayed active on online discussion forum" (60% vs. 49%), Mann-Whitney U = 11773.5, p = .05, d = .22.

Figure 4.1a. "Instructor posted material (i.e., pre-recorded lecture and readings) prior to the class and used live class sessions for discussion, questions and active learning activities"

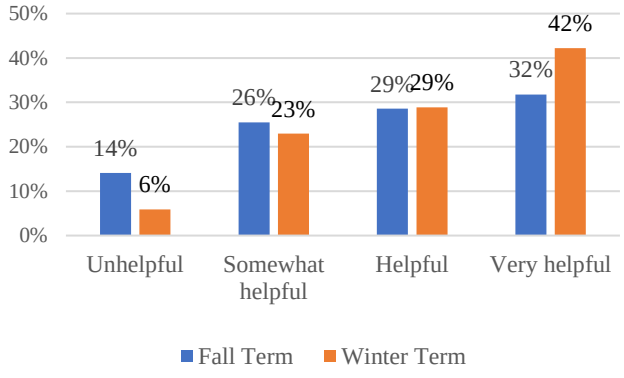
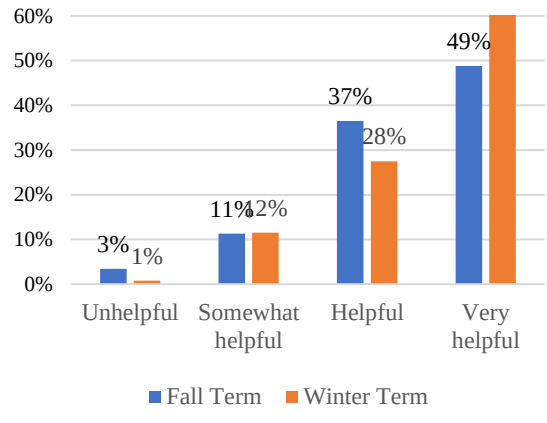


Figure 4.1b. "Instructor stayed active on online discussion forum (e.g., Piazza)"



Learning activities: As presented in Figures 4.2a, a higher proportion of Winter Term respondents than those in the Fall Term (35% vs. 23%) indicated that working on a team project outside of class was very helpful (Figure 4.2a), Mann-Whitney U = 11261, p = .002, d = .35. In addition, a smaller proportion of respondents in the Winter Term, although still most (64% vs 53%), found learning with less interaction

with their peers to be a substantial challenge (i.e., "quite a challenge" or "a huge challenge") (Figure 4.2b), Mann-Whitney $U = 15540.5$, $p = .005$, $d = -.08$.

Figure 4.2a. "Working on a team project outside of class"

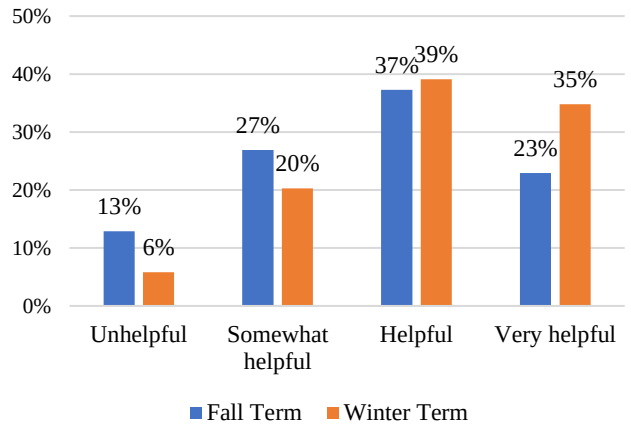
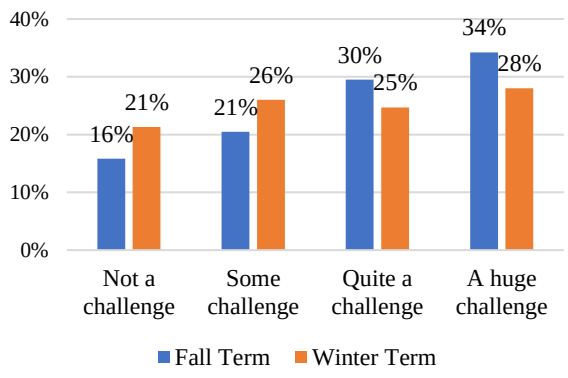


Figure 4.2b. "Learning while having less interaction with my classmates"



Adaptability to the online environment: As shown in Figures 4.3, a higher proportion of the respondents in the Winter than Fall term (42% vs. 26%) strongly agreed that they used different learning strategies when learning online than they would in person, Mann-Whitney $U = 13843$, $p = .003$, $d = .10$. The proportion of respondents who agreed or strongly agreed that online instruction provided the same quality of education as in-person instruction rose from 26% in Fall Term to 34% in Winter Term (Figure 6), Manny-Whitney $U = 14777$, $p = .04$, $d = .06$.

Figure 4.3a. "I used different strategies to learn online than I would inperson"

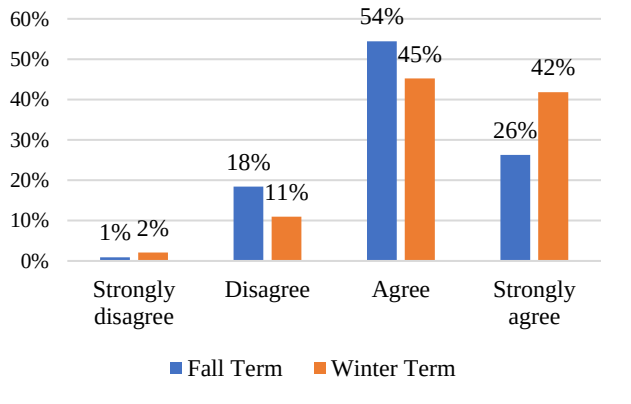
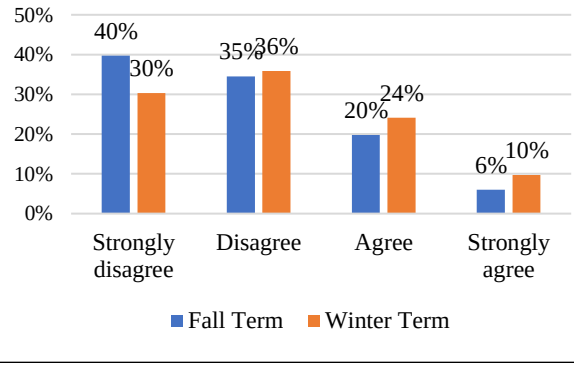


Figure 4.3b. "Online instruction provided the same quality of education as in-person instruction."



Perceived overall impact: The proportion of those respondents who found online instruction beneficial to their learning slightly increased from 37% to 42% between Fall and Winter term (Figure 4.4), with no statistically significant difference (Mann-Whitney $U = 16591$, $p = .21$).

Competency development: Among the 11 competencies asked about in the survey, the only one had a statistically significant difference: a higher proportion of the respondents in Winter Term felt that their

learning experience during the term contributed to their speaking skills (Figure 4.5), Mann-Whitney U = 15010, p = .01, d = .26.

Figure 4.4."Overall, I found that the online instruction this term was ..."

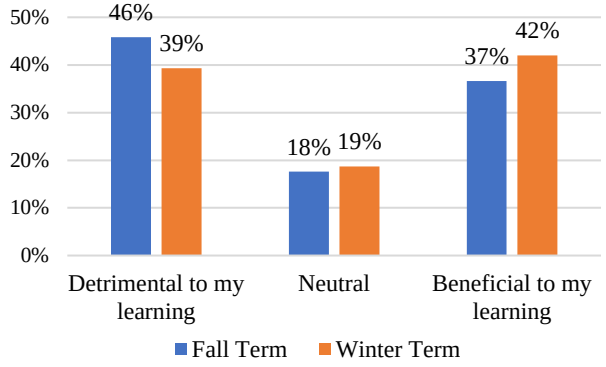
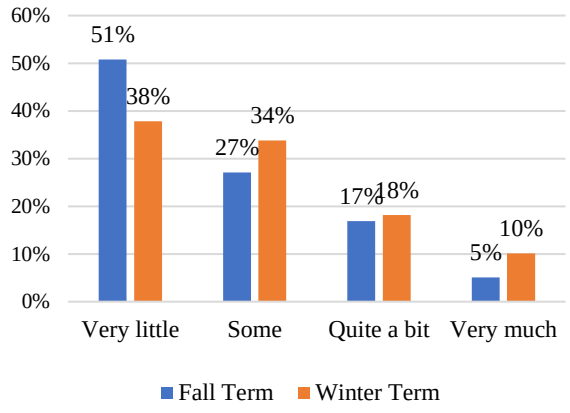


Figure 4.5. "Speaking clearly and effectively"



It should be noted that beyond the items reported above, no statistical improvement between the two terms was found for most aspects of the online learning experience, including perceptions of academic workload, motivation for learning, mental health, and gains in professional and technical skills.

Results from Qualitative Data

In the May 2021 survey, students were explicitly asked whether they felt any improvement over the Fall Term. For example, "Describe your favourite teaching tools or strategies and why you felt they helped you learn. Did you see any improvement over the Fall Term?"

Student reported mixed responses to these open-ended questions but most of indicated that they did not feel any changes between the two terms. Below are some illustrative quotes.

Teaching strategies. While some students felt the positive impact of instructors' efforts to better accommodate online teaching, others did not find improvement in their courses.

> [Mixed] *I found that although the class structure was more organized this semester, the way it was presented was not, and it was easier to fall behind and become overwhelmed* (#93, first-year student)

> [Better] *There was less flip-flopping in winter, everyone was fully committed to a fully online experience from the start so we* ***had clearer expectations*** *from the start.* (#141, senior student)

> [Better] *Fall Term felt much more difficult, this semester professors had ironed out a lot of difficulties from last semester. I greatly appreciated* ***online recordings*** *still being available, making it much easier to fit lecture watching into my schedule, and helping me to understand the content more.* (#179, third-year student)

> [Better] *I feel this term had a HUGE improvement from last. I believe (in EngSci) we were really heard regarding the issue of* ***frequency of assessments*** *being an issue. This semester I feel like all my instructors were extremely considerate regarding when and how for our assessments. I feel like the open book*

assessments conducted this semester takes the factor of any pure memorizing out of the equation and allows for showing a deeper understanding instead. (#152, second-year student)

[Worse] *In my experience, fall term instructors were more considerate of the challenges presented by writing evaluations at home (uploading difficulties, quizzes wouldn't lock out as soon as time was up, etc.), than in the second term, where **evaluations** were very tight on time in an attempt to ensure academic integrity - which did not really make sense to me, at least*. (#190, third-year student)

Perceived challenges. While some students felt less challenged in the Winter Term, challenges related to the online environment remained the same or became greater.

[Better] *Compared to the Fall Term, **reduction in course requirements** helped improve my understanding in courses and my overall experience. This reduction helped balance out the increased stress of an online learning environment and decrease my stress levels.* (#200, second-year student)

[Worse] *The main challenge was **lacking motivation**. This entire term I hardly went to any lectures, didn't keep up with course content, submitted many assignments late or incomplete, and was unprepared for tests and exams. This resulted in lower final marks. This was very unfortunate because when school was in person, I was a very hard-working and disciplined student, and I was always ahead with my work. I faced this challenge both semesters, but the winter semester was worse*. (#205, first-year student)

Adaptability to online learning. Over time, some students adapted to online learning better than others.

[Better] *Peers don't equal friends online like they would in-person. It's virtually all academic as far as I can tell. I study a lot on my own using resources from outside the course, i.e. videos/articles from Google/YouTube. Again, it was the same issues/realizations as last term but I had **better habits/coping mechanisms***. (#279, first-year student)

[Worse] *I can not learn well online, and I **failed to adapt** to the new environment, this made my learning more difficult and in general less effective. It became worse this semester compared to the fall as more classes moved into a more asynchronous mode of delivery.* (#155, second-year student)

[Worse*] I tried very hard in the Fall term to set goals, follow a strict schedule and keep up with expectations of an in-person semester. I found this to be **increasingly difficult** as the Winter Term progressed. The amount of work and stress really wore me down, and it became all I could do to meet the bare minimum of my learning goals by the end of the term. When exams started, I was two weeks behind on lectures for one course. I constantly felt that I was on the brink of collapsing, and at the same time had to push myself to at least complete the mandatory course material. It was detrimental to my health as well as my learning*. (#85, second-year student)

Adjustment to learning strategies. Some students reported they had adjusted their learning strategies to cope with the changes in the online environment.

Compared to fall term, I would discuss course concepts with my classmates and we would create online study guides together more often. Being able to talk through the concepts helped them to sink in better. (#177, third-year student)

focusing my studying on topics I am not familiar with - I've always had a bad habit of just studying in chronological order rather than seeing what I struggle with then tackling those areas. And, with open note

exams, my note taking has shifted to be easier to navigate through. My strategies have not changed, but have improved (#81, senior student)

I changed my planner style compared to the fall term. I had detailed plans and goals that I have to accomplish every day. Also, I started to take more care on myself and started to exercise on a daily basis. (#211, second-year student)

Perception of mental health. More students indicated that they felt a deterioration than improvement in their mental health in the Winter Term.

[Worse] *My mental health suffered from the same factors it did in fall, just it was amplified since my peers struggled more so I had to carry a brunt of the work assigned in groups*. (#292, senior student)

[Worse] *Learning in isolation and the difficulty of working and relaxing in the same physical space (my room) all day, every day. These factors were not different in the fall term. The only difference between the two terms was that during the winter term, it felt never-ending which severely reduced motivation.* (#58, third-year student)

In summary, compared to the Fall Term, a higher proportion of the Winter Term students:

- favoured the use of the inverted classroom approach and instructors staying active on online discussion forums
- found working on a team project outside of class very helpful
- used different learning strategies when learning online than they would in person
- agreed or strongly agreed that online instruction provided the same quality of education as in-person instruction.

Moreover, a decreased proportion of students found learning with less interaction with their peers to be a substantial challenge. However, the effect sizes of all these improvements were small or very small.

Students reported mixed responses to open-ended questions, which showed that some, not most, Winter Term students:

- felt that instructors tried harder to accommodate online teaching
- experienced fewer challenges
- reported they had adjusted their learning strategies to cope with the online environment.

However, more students indicated that they felt a deterioration than improvement in their mental health in the Winter Term.

Section 5. Contributing Factors for Student Success in Learning Online During the Pandemic

With all the challenges presented to students during the pandemic, as presented in the previous sections of this report and our July 2020 report from the May 2020 survey, we wonder: What factors contributed to student success in learning online during the pandemic? We attempt to address this question by identifying factors in two categories: environment-focussed factors and individual-focussed factors. We do not intend to use this broad categorization to argue for the duality between the environmental and individual factors. Rather, we recognize that the environmental and individual factors interact with each other to prohibit or facilitate student success. Our hope is that this categorization will help identify those structural or environmental factors that are modifiable by our Faculty and University so that these factors can potentially inform future decisions and actions in teaching practice.

We drew upon two data sources for this analysis: (a) student comments to open-ended questions in the May 2021 survey and (b) data from seven focus groups[17] that reflected the experiences and perspectives of 16 undergraduate engineering students.

Environment-Focused Factors

We identified the following **environment-focused factors**:

- Greater accessibility to lectures and course materials
- Faculty-student interactions
- Peer communication and collaboration
- Changed approaches to learning assessment
- Culture of care

Greater accessibility to lectures and course materials. Students felt that the availability of recorded lectures, online resources, and asynchronous classes offered them greater flexibility for their time management and greater accessibility to lectures and course materials so that they had more autonomy over their learning.

> *The **recordings** are significant in helping learning because you can speed through the more useless info and repeat things you don't understand at any time you need to see it. It is better than live lectures where the professor is mostly just using one-way communication anyway*. (#164, third-year student)

> ***Having all the lectures and resources available online** TRULY TRULY helped so much this year. I could see a huge difference in my performance, health, and stress level when I didn't have to worry about commuting. Having at least the option to go online gives a lot of flexibility in my learning, and gave me time and motivation to learn a lot more this year as well, and go back to lectures to better understand concepts*. (#166, third-year student)

> *Online learning will always be detrimental due to the volume of hours that are spent in front of a screen. However, certain initiatives can ameliorate the experience such as **recorded lectures and posting notes** for synchronous lectures beforehand*. (#116, senior student)

[17] We ran these focus groups from July 22 to August 13, 2021.

Having recording options *for students to watch lectures and tutorials helped me to create my own personalized study schedule, which enabled me to study and focus on course content with my full potential.* (#149, second-year student)

Recorded lectures *were extremely helpful because if I missed writing something down or I wanted to review something that the professor or TA said, recorded tutorials as well, recorded labs, recorded classes in general, very beneficial because I could go back and review it at double speed if I needed to. If I wanted to just pick up some notes quickly, I could slow it down. I could pause it, which you obviously can't do in real life. So, a lot of benefits there for me personally*. (FG Participant K)

Asynchronous lectures *really benefitted me because I could work at my own pace, and sleep later than I would otherwise, which really helped my well being.* (#286, third-year student)

Suggestions from focus group participants for future teaching:

- *I would really like if the Faculty continued to* ***keep accessibility in mind*** *because I feel like they took it into consideration every step of the way this year. They were always like time zone accessibility, extra time and accessibility, like do you have the right technology? Do you have the right internet? And they were always asking these questions and I love that and I really hope that they* ***continue to pull that value for accessibility and accommodations forward*** *because it definitely helped a lot of people.* (FG Participant M)
- *I'm really hoping that maybe they will* ***start recording the classes*** *because I think it did help a lot of people and then also to just be able to sit there and listen and really absorb rather than thinking like, "Oh, what if this is the last time I'm ever going to hear the professor say this, I better scramble to write it down," and then you're not listening so you're not absorbing it.* (FG Participant O)
- *… the idea of* ***having recorded lectures*** *is just nice for going back and looking over things anyway, and I feel like that's one thing that people are definitely worried about losing when they go back to in-person.* (FG Participant B)

Faculty-student interactions. Students favoured synchronous classes that offered students opportunities to ask questions, a combination of synchronous and asynchronous course delivery, instructors' active involvement in Piazza and office hours, tutorials with a small class, and regular communication with the instructor in group projects. All these facilitated faculty- or TA-student interactions so that students' questions can be answered in a timely manner.

I really liked courses where the ***live synchronous session or office hour*** *was after the due date of these quizzes, so I could ask for help or clarification on my weak points. (#41, second-year student)*

I felt that ***a balance between synchronous and asynchronous content*** *was very crucial in solidifying learnings and improve knowledge retention. The constant presence of the instructors and other teaching team members such as the TAs on online forums was beneficial in clarifying questions as classes moved along which also helped the students to identify weak memories and conduct focused reviews. (#32, second-year student)*

I found it very helpful when the professors were ***active on Piazza*** *and answered the students questions in detail. Some courses ([Course]) only had one or two TAs answering the questions, with the professors never answering any. This led to posts building up and never getting a proper answer to their question, or only receiving vague answers well after they would have been useful. (#210, first-year student)*

For me, personally, I believe that synchronous sessions were definitely the best learning experience. So ***having synchronous sessions and engaging with the prof actively****, at the same time, and being able to ask questions and receive answers, … [It] was a very good learning experience. And then when it was not synchronous or asynchronous, the most important thing was an* ***active Piazza****, or an active teacher answer basis. Because I found that the courses that were the most beneficial to my learning were the courses that the instructors were always active on Piazza, or you could find answers really easily to questions you had, and professors were willing to answer those questions for you.* (FG Participant A)

My favourite learning strategy/tool is ***tutorial section with small number of students*** *(i.e. around 10-20 students per class) since you can get to ask questions and the TA has a lot of time to interact with you where in a class of , lets say, 40 students you really feel awkward for interacting with the professor for more than a couple minutes since you know everyone is waiting for you so in large class you don't usually get your questions answered while you do in small class. (#131, first-year student)*

I was lucky in that we did ***weekly meetings with our supervisor****, and that really helped to have a line with him and be able to ask questions regularly. I know a lot of other capstone teams didn't have as regular communication with their supervisors, and that was a real struggle for them.* (FG Participant P)

Peer communication and collaboration. Students connected with their peers through social media, group projects (that worked well) and/or participation in student clubs. They found peer communication and collaboration through these connections helpful to their learning.

Any ***collaboration with peers*** *was very helpful. Especially student social media groups, and group project groups*. (#101, second-year student)

In our ***online Discord server*** *for our class, we'd get on the voice channel the night before and run through review sessions together which was super helpful*. (#57, second-year student)

Online study groups *with friends and working together with them was very helpful. It was like working together in-person and helping each other out and it also kept everyone motivated to study*. (#143, third-year student)

Being a part of a ***student group*** *was a really great motivator because I knew I had a great support network and it also gave me a greater purpose beyond schoolwork.* ***Group projects/partner work*** *did help a bit, but sometimes it also felt like a burden, and as if it was being a bit forced into the structure of some classes where it didn't fit*. (#118, second-year student)

By being apart of ***extracurricular teams and activities****, I met may other people who were able to give be helpful tips and insight on school. The skills I learned from those peers were very helpful to learn in the online environment. I engaged in more of these activities this term than usual because I was always at home and had a lack of other social activities I'd usually be occupied with*. (#290, second-year student)

I didn't necessarily have classmates within the same course, but I have a few ***friends*** *in U of T in the medical department to study with. We held virtual Library sessions every other day where we would emulate a library or café environment using* ***Discord*** *(Voice chat/Video application) and study in relative silence while passing comments here and there. We figured having just the ambient presence of others would subconsciously help us with focus and motivation and it also alleviated the much needed social interaction that was prevented by the Covid distancing.* ***Teaming up with another person*** *is only effective when one is more knowledgeable and is a mentor for the other. Working with people who are as equally as confused as you is helpful for self*

assurance and motivation but not as an effective learning tactic for a 4 month course. (#63, third-year student)

I had a lot of courses that had group projects. And so I made friends with the people in my group and would meet up with them in person, outdoors, and socially distance. And I think that that really helped me still get to kind of meet other people in my discipline and make new friends, despite being fully online. So I think the ***group projects*** *really helped that*. (FG Participant J)

Changed approaches to learning assessment. Students reported that at-home exams helped alleviate stress, and project-based assignments and open-book exams placed more emphasis on conceptual understandings than memorization.

More controversially, I really enjoyed the experience of taking exams online. When taking exams in person we are often subject to very small tables where we cannot fit all of our materials, wobbly desks, etc. Not to mention the endless distractions of students sighing too loudly, tapping their feet, aggressively drinking from water bottles, furiously writing and punching numbers into their calculators so aggressively that you can hear every movement, etc. ***Taking an exam from home*** *provided a much more calm and focused environment, where I could not be stressed out by hearing the person next to me furiously flipping pages as they speed through the exam while I'm stuck on a question*. (#203, third-year student)

I have personally been able to better adapt to the online methodology of learning because my learning path is not the conventional "sitting in lecture". Thus, when assignments shifted from the typical exams to more project-based assignments, it truly encouraged and aided my learning. This is solely out of personal experience, but I think that ***project-based assignments*** *challenge students in a much more holistic way than regular examinations, since they invite us to incorporate what we have learned in multiple classes*. (#192, third-year student)

I think that because a lot of midterms were open book, that changed how I studied. I definitely think that ***open book midterms or exams*** *feel better for people, because it feels like a better reflection of their learning. And for me, it felt like I was being rewarded for better note-taking and better organization of files and better I guess paying attention in lecture, as opposed to just regurgitating memorized stuff*. (FG Participant B)

Most of all of my exams were ***open book****. Yeah, for engineering, I think so. And I agree with like focusing on understanding rather than memorization because when were in person I feel like a lot of the study time and also in class time, right? It was just spent making sure you had all the formulas written down, memorize but then obviously with open book exams … the profs told us that the questions were designed to test understanding of the application rather than memorization, right? So because of that, in class, I would focus more on understanding and when I was doing my homework and studying, I would also focus more on applying. I much prefer that because in real life we can always just look up a formula, but you have to understand which formula to use or how to use it, or whether it's the results makes sense or whatever*. (FG Participant N)

Culture of care. Students felt grateful when instructors expressed their care for students and made efforts to accommodate student needs.

Each staff & faculty member were very helpful & encouraging & worked so hard in creating an environment for me that I need to learn in, and I am very grateful. (#86, third-year student)

I think profs were more accommodating with the learning. Some profs lessened the course load and they really tried to make the courses as fun and interactive as possible. Their efforts to stay happy and engaging really did have an impact. (#163, third-year student)

I think professors who understood that, or professors who were vocally supportive, just helped. And in general, if a professor was more vocal about being accommodating with deadlines or with accessibility concerns or something, it just made that communication more comfortable. (FG Participant B)

Individual-Focused Factors

We identified the following **individual-focused factors**:

- Student effort and agency
- Saving commuting time
- Social support from family and friends
- Independent and self-motivated learning approaches

Student efforts and agency. Students demonstrated their agency by adjusting their learning strategies and making active efforts to address the challenges they encountered in the exclusively online environment.

*I felt that **taking small breaks while studying** helped me study better as it prevented fatigue. I used the same strategies for studying in the Fall term and continued using them as I found them to be effective for me* (#143, third-year student)

*I originally had no defined timetable in the fall term, and that made learning more difficult. I followed one in the winter term, and it helped keep me on track with my learning very well. Moving forward, I am going to **revise my timetable to be task-based** rather than time-based as that would suit me best*. (#276, first-year student)

*Generally speaking, I found it very difficult to focus this semester. I think this is because we have been online for so long and I was a little burned out, but it made my studying a lot less efficient and forced me to **explore new strategies** like group-studying and pomodoro studying when I was alone*. (#118, second-year student)

*I think I **made active efforts to go out and socialize** because... I guess the way I processed it was like, "it's just a Zoom link, just go. If you don't want to stay there, you can leave" kind of thing. So I think I went now to more events, which was good for my mental health. And I think I met a lot more people that way as well*. (FG Participant D)

*Last year, I was on the other side of the world. So, a lot of lectures and tutorials, I wasn't able to attend in-person. I mean, I couldn't attend live. So, a good thing about that is I can **schedule my lectures** to a period of a day such as morning, and I'm able to free up my entire afternoon to do work or study. That's a great thing about schedule flexibility. I get to change the book instead of having the university assigning the time to me*. (FG Participant L)

Saving commuting time. Some of those students who previously had a long time commuting to the campus felt positive about their online learning experience as the saved commuting time helped them rest better and motivate them to learn better, although this positive impact varied for individuals.

My sessional gpa for both fall and winter semesters dropped by 0.5 compared to in-person learning due to hearing difficulties and lack of motivation. I can't read my professor's lips anymore which makes it much

*harder to learn. The only good thing about online learning is that I can choose a study schedule that works best for me and **I don't have to commute**.* (#236, third-year student)

*I was also a commuter student, so that also **made things super flexible**. Even like review sessions, I wouldn't be able to always come down on the weekends for that. Now, if they were online, I could basically always attend those or even after school or whatever.* (FG Participant D)

*I'm also commuter about one hour commute each way, so it was nice to not have to commute. I just have more time. I **got enough sleep**, which made a big difference because obviously if I can sleep, then I can pay attention in class rather than be half asleep in class. So that was really helpful having enough sleep, and I guess I also think it was nice that most clubs and teams kept trying to run so that now **I could participate** without like staying downtown until like 9:00 PM or going downtown on Saturday, but I could... I was able to participate in all of these things*. (FG Participant N)

Social support from family and friends. Social support from family members and friends played a positive role in students' learning environment at home.

*Personally I benefited from less distraction and more time for studies due to **less commuting** etc. Not all of my peers felt this way, in fact most did not. I also **had a very supportive network of friends and family** to help me through this difficult time*. (#83, senior student)

*I think I'm very much in the minority. My grades actually went up during online learning courses almost by full letter grade, with my motivation to learn and my mental health also increasing. I was **near my family**. I **got all the support that I need from my friends** and I was comfortable with my learning environment. And the course content was also well paced. It was under my control. So it was very enjoyable*. (FG Participant G)

*A good thing is, because of where I'm located, COVID isn't much intense compared to other countries. So, I got a chance to **connect with my family members, aunts, uncles, cousins**, and I got closer to them. So, I think there's an upside and there's a downside for me. Overall, it works well and I don't think I feel socially isolated. And where I'm located, restaurants are still open. Myself and my parents are still able to go out for dinner, go out for lunch. I was able to **meet my older friends** as well, friends from many years ago and we reconnected. That's something that I really treasured throughout the pandemic*. (FG Participant L)

Independent and self-motivated learning approaches. Comments from focus group participants suggest that different learning approaches and styles played a role in students' learning experience.

*But when it comes down to it, if there's something that needs to be done, I prefer to do it alone. Or if it's a group project, yeah, I have to work with other people. That's great. I have no problem with that. I enjoy it. However, to your point, I would say that I am self motivated and I can just sit down and get stuff done. And I **prefer that quiet time**, like [Participant L] mentioned, to just get things done, and I prefer not to have other people around because I find that distracting*. (FG Participant K)

*I **focused a lot better in person during those lectures** and just having that set time and I could get myself to focus for the 50 minutes and being surrounded by everyone who was also paying attention to the prof was helpful versus when I was at home. I just fidget with things and get distracted and... So I guess just learning how to deal with those quirks of online learning made me change the way that I was doing things*. (FG Participant C)

*I was **closer to a good student online than I was in person**. Because like I said, in person I had a lot of trouble focusing during lectures. So I would use a lot of different resources to try to piece together the*

information. I'd constantly be around people and learn from them. And I think when I was in person, I probably learned more untraditionally than I did online. Like this year, I got very much used to actually taking the notes during lecture and actually listening to the lecture and learning from the lecture and then doing the problem sets from the lecture. Sorry. Whereas in person, I can only think of a handful of courses where I actually found the lectures useful. And that's simply because, I guess, learning six hours in a row from different courses in a very structured manner doesn't work for me. (FG Participant D)

Being aware of different learning approaches and styles among students, some focus group participants suggested the Faculty offer options to accommodate different learning preferences.

- *… if they could **offer more resources that make it accessible to learn in different styles**, that would be appreciated so I at least have options to work through*. (FG Participant D)
- *I think different people will be better online and [others] will be better in person. And I do think that **there needs to be some mechanism in place such that people who on both sides of that spectrum**, let's call it, will be able to take full advantage of how courses are delivered*. (FG Participant H)
- *But I think the main takeaway is some people actually use thrive in an online learning environment and other people thrive much more in in-person learning. And I don't necessarily see it as a negative impact per se, but kind of a flipping of narrative. People who prefer in-person learning will eventually thrive when we go back into campus, I think. And people who prefer online will most likely kind of have consequences, along with that, too. … But I think what's important is that some people actually do better. And we kind of need to learn how to **provide options for people to do both**, depending on what's comfortable for them*. (FG Participant G)

In Summary, based on the May 2021 survey comments and subsequent focus groups, we identified environment- and individual-focused factors that contributed to student success in learning online during the pandemic.

Environment-focused factors	Individual-focused factors
• Greater accessibility to lectures and course materials • Faculty-student interactions • Peer communication and collaboration • Changed approaches to learning assessment • Culture of care	• Student effort and agency • Saving commuting time • Social support from family and friends • Independent and self-motivated learning approaches