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

Transition to Remote Learning: Engineering Students' Perspectives in Spring 2020

Report on a Student Survey

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Executive Summary

As a result of the COVID-19 pandemic, engineering students completed the last few weeks of their courses in the Winter Term (January-April) 2020 through remote learning after a rapid transition to entirely online instruction starting on March 13, 2020 at the University of Toronto. An undergraduate student survey was administered at the Faculty of Applied Science & Engineering (FASE) in May 2020 to capture student perceptions of their experiences with this transition. A total of 801 students responded to the survey, with a response rate of 22%.

Structure of the Report. In this document, we have reported student perceptions of their learning experiences after the transition to remote learning in spring 2020 in the following areas:

- Overall experiences;
- Changes in learning motivation and behaviour;
- Experiences with online courses;
- Experiences with final assessments;
- Perceived academic workload;
- Access to online learning; and
- Mental health.

Further, we have summarized students' perceptions of the challenges and benefits in future online learning and their recommendations.

Key Findings. Our data analysis informed the following ten key findings:

1. Students reported a number of changes associated with the rapid transition to remote learning including decreased motivation for learning (reported by 77% of the respondents), reduced class participation (63%) and a decline in mental health (48%) (see Sections 3 and 8); underlying all these changes was the lack of social interactions in the online environment (see qualitative results in Sections 1, 8 and 9).
2. Students perceived that the top challenges after the online transition resided in collaborative learning, completion of final assignments / exams, and class participation (reported by around half of the respondents as a substantial challenge) (see Sections 4.1 and 5).
3. The most favorable online teaching techniques for students involved recording live class sessions (reported by 87% of the respondents as helpful or very helpful), using pre-prepared recordings (72%), and synchronous classes (65%) (see Section 4.2).
4. Students favored open-book exams and take-home assignments over closed-book exams or multiple-choice questions (see Section 5).
5. Approximately half the students felt that their workload increased as a result of the transition to remote learning; the perception of an increased workload was related to various challenges such as accessing appropriate technologies, difficulties communicating for group projects, changed ways of teaching and learning, or increased responsibilities at home (see Section 6).
6. A small but significant portion of students reported encountering substantial technology and workspace challenges, including having quiet space for learning, using online learning tools, having reliable access to affordable internet and being in a different time zone. These issues appeared to be severe for some students, thus raising equity concerns (see Section 8).

7. The online learning environment provided some benefits to students, including availability of lecture recordings, being able to study at their own pace and ask questions more easily (for many but not all students), and saving time from commuting (see student comments in Section 1).
8. Student perceptions of experiences with the online transition varied by year and program of study. In particular, when it came to year, *first-year students* were more likely than their peers in other years to attend fewer classes after the transition (Figure 6, Section 3) and to view understanding course materials in online learning to be challenging (Figure 9, Section 4). In terms of programs, *Engineering Science* students were most likely to have a negative perception of their learning after the transition (Figure 5, Section 1; Figure 7, Section 3); *Civil Engineering students* were most likely to find coordination of teamwork challenging (Figure 10, Section 4) but least likely to perceive that workload increased (Figure 19, Section 6).
9. The survey data revealed some equity concerns. Students from several under-represented groups, such as women, international students, and those who identified themselves with LGBTQ and registered with Accessibility Services, reported more challenges after the transition to online learning than their peers. Specifically, students who indicated that they have poor or fair mental health in general were more likely than their peers to report declines in mental health after the transition (Section 8); *international students* were more likely than domestic students to report challenges due to being in a different time zone, lack of reliable access to internet, and lack of unrestricted access to their own devices (Section 6); and *women, LGBTQ-identified students and students who registered with Accessibility Services* were more likely than their peers to indicate mental health related challenges (Section 8).
10. Students anticipated that the main challenges for future online learning would be continued social isolation; absence of labs or hands-on activities; a lack of motivation or focus; and difficulties accessing technology and online learning (Section 9).

Recommendations. Based on the findings and the student recommendations from the survey, we suggest that actions be taken to better support student success in this fall's predominantly online learning environment. Recommendations are listed for instructors, FASE, and students.

Recommendations for individual instructors:

Improving course delivery

- The vast majority of students found recordings of live class sessions beneficial to their learning. We recommend that **instructors record all live class sessions and ensure that these recordings are posted promptly** so that students can use the recordings for learning at any time, and thereby mitigate barriers created by time zones or inadequate internet connectivity.
- Student comments suggested that various challenges caused them to perceive that workload increased when learning online. We recommend that **instructors consider expectations carefully and streamline workload to focus on key learning outcomes.**
- Students commented that they appreciated *quality*, *shorter* lecture recordings (e.g., one topic per video), materials created by the instructors themselves (while using textbook readings and external sources as supplementary resources), and more checkpoints or mini-assignments to help them stay on track. We recommend that **instructors vary the design of the short instructional videos they create, to promote student engagement and learning** (e.g., varying video types between PowerPoint with audio, talking head, locations reflecting the topic etc.).

- Students found question and discussion boards very helpful, if they were kept current. We recommend that **instructors set up mechanisms to monitor the question and discussion boards to answer questions in a timely manner**.

Improving synchronous teaching

- Students reported that strong connections with their peers improved their understanding of the material, and increased their learning enjoyment. We recommend that **instructors create opportunities to help students build rapport from the start of a course** and consider dividing classes into smaller, designated groups for some activities. These efforts can help students actively participate in breakout group discussion and group assignments. Student comments suggested that active monitoring of breakout rooms by instructors or TAs, where possible, would also increase student engagement and satisfaction.
- Students commented that when instructors had their mics and cameras turned on while they taught or held office hours, they felt better supported and connected. We recommend that **instructors have their audio and cameras on while teaching live classes and during office hours**. This will also increase the social interactions between the instructors and the students.
- Some students noted that instructors did not always explain course materials they posted. We recommend that **instructors draw connections and explain the relevance of material for asynchronous learning in their synchronous class sessions**.

Improving learning assessment

- Students commented that they favoured take-home projects, open-book exams, and open-ended questions as they found these methods to better assess their learning and help discourage cheating. We recommend that where appropriate, **instructors use take-home projects and open-book exams to be the main methods for learning assessment and incorporate open-ended questions in exams**. Instructors should also take into account possible issues with time zones and internet connectivity when estimating students' completion time for assessments.
- Students noted concerns regarding the formats used in some online exams. We recommend that **instructors use a more examinee-friendly exam format** by allowing students to be able to see all the questions before the start of the exam, move backwards to previous questions during the exam, and submit their work easily (e.g., using a pdf file to show diagrams etc.); and by assigning partial marks, where appropriate.

Recommendations for FASE:

Faculty-wide guidelines

- Students noted that the range of online instructional approaches used by instructors was sometimes challenging. We recommend that **the Faculty provide instructors with guidelines and resources to promote consistency across courses** including: what time to start the class (whether or not ten minutes past the hour), finishing each class on time (not running overtime), preferred software platforms, the formats for final assignments and exams, and how to accommodate students' special needs in online learning.
- The survey data revealed that many students felt less motivated to learn online, which appeared to significantly impede their engagement. We recommend that **the Faculty make available tip sheets, orientation classes, or online tutorials on how to learn online**. These resources could

cover: how to remain motivated and engaged in online learning throughout the term; how to increase ownership of their learning and become more self-disciplined in their learning; how to manage time better; how to interact with instructors and peer students effectively; and how to engage with different learning activities, such as breakout room discussion, group work, and labs, in the online environment.

Department initiatives

- The survey data revealed that issues with accessing online learning, although not widespread, were severe for some students. We recommend that **departments survey their students before the start of the fall term**. This survey should include questions related to having access to a quiet space for study, time zone, reliable internet access, and any restrictions on accessing online learning tools. The survey results could be compiled by program-year and made available to instructors before the start of the fall term.
- The survey data showed variations in students' perceived challenges. For example, students from some programs were less likely than those from other programs to report that they had positive experience after the transition to online learning (see Figure 4, Section 1; Figure 19, Section 6). We recommend that **departments review these challenges to identify any that could be more relevant to their program, and develop strategies to address them**.

Student support

- The survey data showed that first-year students tended to perceive more challenges in coping with the online environment. We recommend that **mechanisms be established to allow someone to proactively check-in with new students on a regular basis about their learning engagement and general well-being**. This could include forming learning partners among peers and/or enhancing the existing APS100 mentorship program.
- The survey data showed that nearly half of the students felt that their mental health declined after the transition to online learning, and those whose mental health was generally not good were more likely to feel mental-health-related challenges. Students from under-represented groups indicated additional stress in the context of the pandemic; and some students reported difficulties accessing mental health support resources. We recommend that **the Faculty's mental health programs provide support and resources to help students relieve mental health challenges related to online learning and communicate what supports are available and how to access them**.
- Many students asked that the social online environment be improved to help them to build friendship and extend peer relationships, increase their support network, and widen the number of possible study group partners. We recommend that **the Faculty promote engagement in its online social environment for engineering students.** Various activities can be encouraged and reinforced, including enhancing the online presence of engineering clubs and teams, establishing virtual study groups, opening virtual social spaces dedicated to groups/cohorts of engineering students, and sponsoring online competitions, teams and games.

University support

- Some students who had substantial challenge in having quiet space or internet connectivity asked for libraries and residences being made available to those in need. We recommend that **where**

possible, the University open up libraries and make bookable rooms available so that those students in need can obtain the resources and space they need.

Recommendations for engineering students:

Prepare well for the journey

- The survey data suggested that those students who did well in an online environment were motivated and disciplined learners. We recommend that **students work out a personal study plan that outlines their own strategies to manage the online learning environment** so that they can become more self-disciplined and take more ownership of their learning. They should create and track a weekly schedule for the activities and deliverables in each of their courses based on course expectations.
- The survey data showed that some students were challenged by how the online environment changed the ways they needed to approach learning. We recommend that **students recognize and anticipate that learning online can be different and take steps to prepare themselves**. Before the start of the fall term, students should review the guidelines and resources that the Faculty has posted for students and note down all the support resources for later use.

Navigate the term strategically

- Lack of social interactions was a significant challenge identified in the survey. We recommend that **students establish and sustain a community of learning for themselves**, by reaching out to other students to form a study group or find study partners, and utilize opportunities and resources offered by classes or programs, to increase their online social interactions. We also encourage **students to join online clubs and social groups** within the Faculty and UofT to make friends, pursue hobbies and other interests, and get to know other students outside of the classroom environment.
- To enhance social interactions during live class sessions, we recommend that **students create a personal profile and add a picture of themselves to all the online learning platforms they are using** so that their instructors and peer students can start to recognize them in class. For the same reason, they should turn on their video camera, when feasible, in small group discussions, office hours, or other situations where interaction is essential. This will encourage group engagement and help students to become familiar and comfortable with interacting professionally online, which will presumably become increasingly important throughout their careers as engineers.
- The survey data showed that attending fewer classes as a result of online learning detracted from the overall learning experience. We recommend that **students should aim to attend all classes even if recordings are available** so that they can stay engaged and organized.

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1. Introduction

Due to the COVID-19 pandemic, the University of Toronto cancelled all in-person courses and moved all classes to other means of instruction starting on March 16th, 2020. Engineering students, along with their peers across the University, managed to complete the rest of their courses and other academic activities in the Winter Term (January-April) 2020 through emergency online learning.

The *Undergraduate Student Survey on the Recent Transition to Online Learning* was administered from May 11 to 25, 2020 to all undergraduate students of the Faculty of Applied Science & Engineering (FASE) who took courses during the Winter Term 2020. A total of 801 undergraduate engineering students responded to the survey, with a response rate of 22%, which is typical of student surveys within FASE. Lower-year students (Years 1 and 2), Engineering Science students, and women were over-represented in the sample (See details in the Appendix). The data were collected and analyzed under the leadership of the Institute for Studies in Transdisciplinary Engineering Education and Practice (ISTEP).

This report presents the survey results from the total respondents and (statistically) significant differences in perceptions among different student groups, as well as themes from student comments that helped explain some of the findings from the quantitative data and student recommendations for future remote teaching and learning. We have included our recommendations based on these findings in the Executive Summary section alone.

2. Overall Experiences

The survey asked two questions to probe students' overall perceptions of their experiences with the online transition, and an open-ended question for comments.

Perceptions of the Online Transition and Student Learning

Overall, student perceptions of the transition to entirely online instruction (hereinafter referred to the online transition) were mixed. While 42% of the respondents rated their experience with the online transition positively (5-7 on a 7-point scale), 33% provided negative ratings (1-3 on the same scale), with a quarter rated the transition as adequate (middle rating of 4) (Figure 1), $M = 4.14$, $SD = 1.62$. Nearly half of the respondents (48%) did not find the online instruction after the transition beneficial to their learning (1-3 on a 7-point scale), in contrast to 28% who indicated that the online instruction benefited their learning (5-7) (Figure 2), $M = 3.71$, $SD = 1.58$. It is unclear if students replied to this question in relative or absolute terms, whether for example, 28% of students found that online instruction benefited their learning relative to in-person instruction. Students' perceptions of their experiences with the online transition was strongly correlated to the perceived impact of online instruction on their learning, $r = .705$, $p < .001$.

Figure 1. I found the transition ...

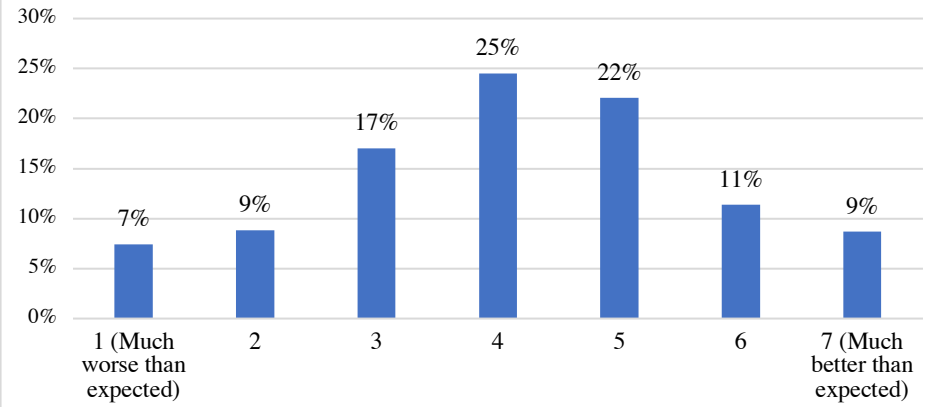
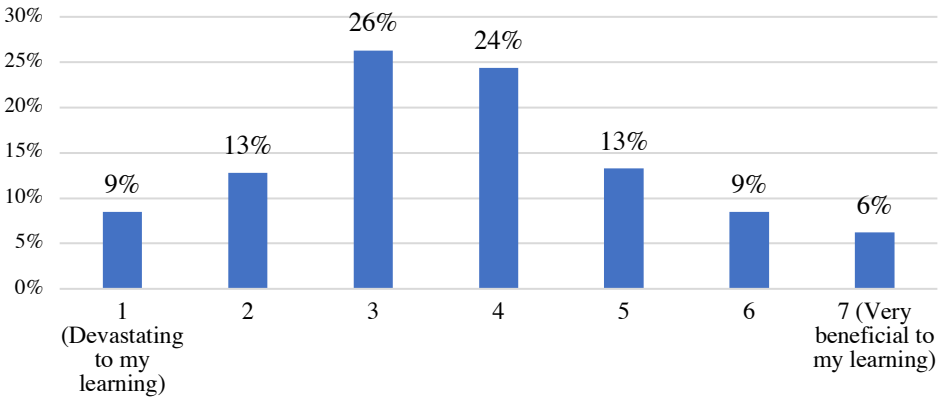


Figure 2. I found that online instruction was …



Student Comments on Overall Experiences with the Online Transition

Student comments revealed that many students who had negative perceptions of their overall experiences suffered from **a decreased motivation for learning** after the online transition. They felt demotivated or overwhelmed by lack of social interactions and other challenges they encountered in the online learning, including lack of peer support, cancellation of labs and hands-on activities, difficulty in group work, dissatisfaction with assessments, the distractions from family surroundings; some simply preferred an in-person learning environment. These affective factors affected student learning in negative ways. A small number of students suggested that they experienced surface learning. Below are some illustrating quotes.

> *"Overall, completely online learning resulted in me not being motivated to learn. As such, it was harder to get myself to concentrate and study for long periods of time, which resulted in me cramming a lot more and not knowing the material as well as I normally would."* (rated 3 for the impact of online instruction on learning; lack of motivation and surface learning)

> *"Online instruction numbs your mind. You spend hours of your day sitting at your desk 'attending' lectures and then hours of your day at the same desk doing homework. There is no distinction between class and homework, whereas there typically is a distinction between on-campus instruction and home.*

Thus it becomes increasingly difficult to maintain focus and your learning suffers as a result." (rated 1 (devastating) for the impact of online instruction on learning; reasons for lack of motivation and how this affected learning)

"In-class learning experience was very joyful and very motivating to myself. I like to sit in the first row and listen to the professor very carefully. Having somewhere to go and sit for lectures, having the intention to "attend" classes physically somehow motivate me to learn and study more. At home, under a more comfortable situation and having no peers around study together makes it a very hard time for me to motivate myself to sit and focus on the course contents. Therefore the transition to online learning experience to me is much worse because it seriously damaged my motivation to study." (rated 3 for the impact of online instruction on learning; reasons for lack of motivation)

"Online instruction HUGELY promoted 'regurgitative learning'" (rated 1 for the impact of online instruction on learning; surface learning)

"I honestly don't really think I learned that much, I was mostly just scrambling to get work done because project requirements for design projects changed and that took up most of my time." (rated 2 for the impact of online instruction on learning; surface learning)

Some students reported that **teaching issues**, such as their instructors relying on reading off the slides, using seemingly irrelevant or outdated materials, posting notes very late, and being disorganized, had affected their learning. However, these issues should be resolved when instructors have more time to prepare for online teaching in the fall.

"Some professors were good, but for [Course name] the professor just told us to watch youtube MIT opencourseware classes that were not directly related to the problem sets, and I found that they did not adequately prepare me for the final exam because there was a disconnect. Additionally the tutorials for that class were cancelled after we transitioned online :(and I found tutorials in general a good connection and very helpful." (rated 3 for the impact of online instruction on learning)

"1/3 of my instructors provided live learning and posted notes that were up-to-date and that was very helpful with online learning. However, the rest left us with reused lecture notes/videos which were not very motivational, leading me to try to cut corners while studying." (rated 4 for the impact of online instruction on learning)

Those students who rated their experiences as 4 (neutral) tended to offer **balanced views of their online learning experiences.** While lack of motivation was also an issue for some students, they seemed to be able to manage it.

"For some courses, having appropriate resources (recorded lectures, regular communication from professors) made the transition smooth and allowed me to organize my time (with no commuting time now) and finish the manageable work. However, for some other courses where minimal lecture recording were provided and students were asked to mainly learn from the textbook ([Course name]), this made it much easier to fall behind and lose track of learning, and thus it negatively affected my learning." (rated 4 for the impact of online instruction on learning; balanced views)

"I did not notice a particularly negative/positive change in my learning. I think there are huge benefits to online learning (more flexible hours, more time to work on things), but also huge detriments (lectures are hard to follow, time zone differences). But the same level of pros/cons can be said for in-person

lectures, so the transition to online instruction was a neutral experience with regards to my learning." (rated 4 for the impact of online instruction on learning; balanced views)

"I liked having the freedom to adjust my schedule to what worked best for me, in terms of when I "attended" or consumed lecture material. However, it was difficult being at home not having social interaction with others and having a lot less motivation to learn. I felt I still absorbed the material, but it was much more difficult to focus and devote time to learning at home." (rated 4 for the impact of online instruction on learning; lack of motivation but still manageable)

Those who rated their experiences positively felt that they **benefited** from the availability of lecture recordings, being able to study at their own pace and ask questions more easily (for many but not all students), and saving time from a long commute. A small number of students felt more motivated to learn due to having less distraction from surroundings and being able to study at their own pace.

"I believe that being able to reference recorded lectures was extremely beneficial to my learning. Without recordings, if you miss something in lecture, it's pretty much gone forever, but if the lecture is recorded it is super easy to just re-watch that section and I found myself doing this constantly, and it really helped me understand what I was being taught. This was the biggest benefit I got from online learning. However, I really miss the environment on campus and being able to work with my friends in person." (rated 6 for the impact of online instruction on learning; recording)

"I have found in the past that I work well from home and on my own, and so transitioning to online learning actually improved my experiences in my courses. I spent more time focusing on understanding the course material as opposed to sitting in a lecture hall digesting the material at the lecturer's pace. Being able to adjust content to my own pace, while time-consuming, allowed me to develop a deeper understanding of the material and hence my performance in my courses improved towards the end of the semester." (rated 6 for the impact of online instruction on learning; learning at one's own pace and learning preference)

"I personally enjoyed online learning because I didn't have to deal with the social anxiety of sitting in a class of a hundred students. I felt more free to ask questions during class which I would never do in person. I also noticed other students that didn't speak up in class asking questions when classes were online." (rated 6 for the impact of online instruction on learning; asking questions more easily)

"I found online learning more useful than I expected because it saved time a lot since I did not have to commute everyday which allowed me to stay healthier (no more sleep deprivation). I was able to use the saved time wisely by catching up on courses and spending more time reviewing materials to achieve higher grades." (rated 5 for the impact of online instruction on learning; not having to commute)

"I'm not sure why, but I felt more motivated and focused when studying at home. Maybe it's because I don't have the distraction of other people around..." (rated 6 for the impact of online instruction on learning; feeling more motivated)

"Online learning gave me much more time to learn at my own pace as it felt like I was setting my own schedule. Surprisingly to me, I actually felt much more motivation to learn." (rated 6 for the impact of online instruction on learning; feeling more motivated)

Some students indicated that learning well in an online environment was related to one's **learning preferences** and the capacity for **self-discipline**. Thus, the online learning environment seems to offer opportunities for students to take more of the ownership to their learning and to be more self-disciplined.

"Online learning allowed me to feel undisturbed at times when I needed to work out some concepts which is not always feasible at a classroom setting when surrounded by classmates or the need to transition between locations before and after lectures. Having that said, I often preferred studying alone as that had always an learning habit suitable for me." (rated 6 for the impact of online instruction on learning; learning preference)

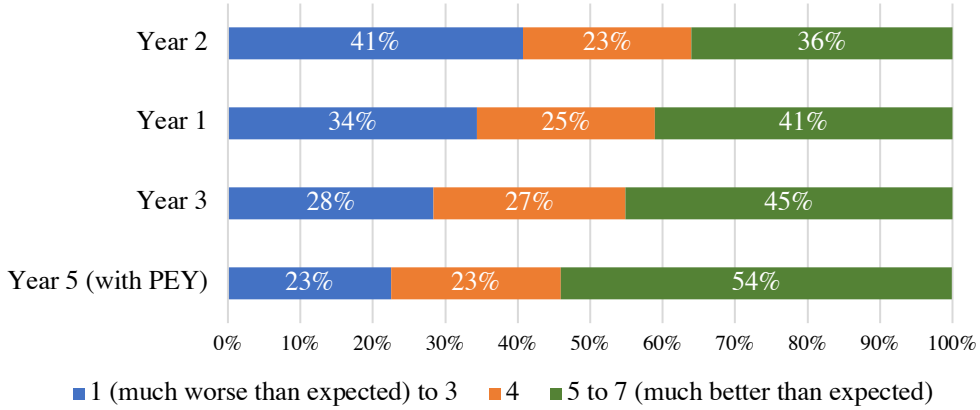
"… Online learning requires self-discipline— How it affects a single student is dependent on that student and there's nothing beyond providing the necessary tools and assistance the university can do, it's a personal sacrifice in order to excel." (rated 5 for the impact of online instruction on learning; self-discipline)

"in some ways, I was able to work at my own pace, allowing me more agency in how I learned. However, this also caused me some difficulty to stay disciplined and focused on my work. Overall, I don't think online learning benefited or impeded my learning." (rated 4 for the impact of online instruction on learning; self-discipline and ownership to learning)

Significant Group Differences

Statistically significant difference by year of study was found in the overall perceptions of the online transition experiences, Kruskal-Wallis $H(3) = 16.71$, $p < .01$[1]: *students in lower years (Years 1 and 2)* were more likely than Year 5 students (with PEY) to rate their experience negatively (as measured by 1-3 on a 7-point Likert scale) (Figure 3). No significant difference by year of study was found with respect to the impact of online instruction on student learning.

Figure 3. "I found the transition ...": Differency by year of study



In addition, statistically significant differences among programs of study were found in the perceptions of the transition experiences, $H(8) = 22.41$, $p < .01$; and in the impact of online instruction on student

[1] A Kruskal-Wallis test was used to detect significant differences among more than two groups. H value is reported here, along with degree of freedom (in this case, df =3). When the p value is less than .05, the result indicates that there was statistically significant difference among the groups being compared, presumably at least between the group with the highest mean rank and the group with the lowest mean rank. In all of the graphs for multiple-group comparison in this report, the comparison groups are presented in the ascending order of the mean ranks in the Kruskal-Wallis test.

learning, $H(8) = 23.52$, $p < .01$. Figure 4 shows that *students from Computer Engineering, TrackOne, Electrical Engineering, and Engineering Science programs* (their mean ranks close to each other) were less likely than their peers in other programs to perceive their experiences after the online transition positively whereas *students from Chemical Engineering and Materials Science and Engineering (or MSE)* were more likely to view their experiences positively. Figure 5 indicates that *Engineering Science students* were most likely, but students from Chemical Engineering, MSE and Mechanical Engineering were less likely than their peers in other programs, to have a negative perception about their learning after the online transition.

Comparison was made for the first-year students among TrackOne, Engineering Science and Core-8 students. *Engineering Science* students were more likely than Core-8 students to have a negative perception of their experience with the online transition, Mann-Whitney $U = 3753$, $p < .05$; and to perceive a negative impact on their learning after the online transition, Mann-Whitney $U = 3505$, $p < .01$.

Figure 4. "I found the transition ...": Difference by program of study

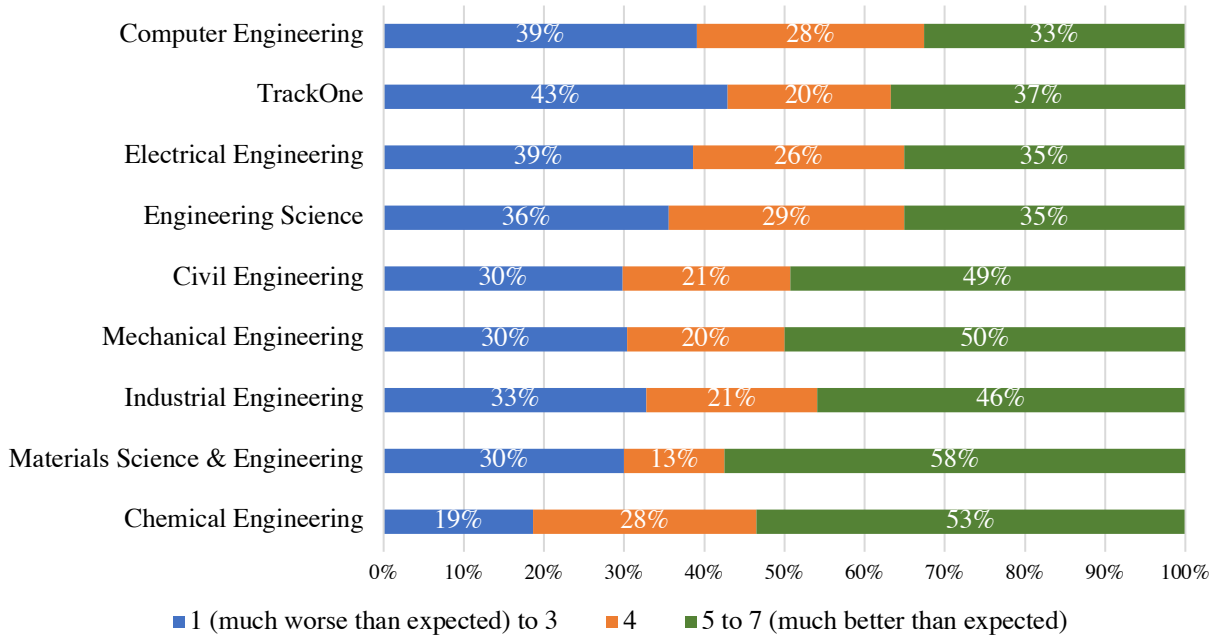
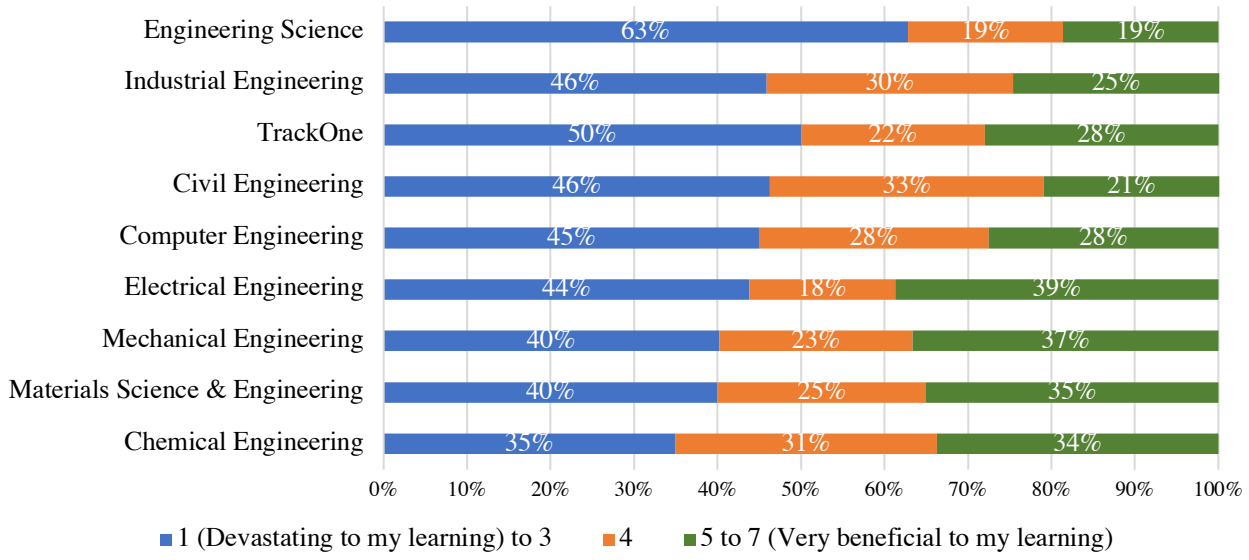


Figure 5. "I found online instruction was ...": Difference by program of study



3. Changes in Learning Motivation and Behaviours

The survey probed the changes of motivation for learning and two related observable behaviours—attending classes and asking questions.

Overall Findings on Changes in Learning Motivation and Behaviours

As shown in the student comments reported in the previous section, changes in students' motivation for learning were associated with the online transition along with related behaviours such as attending classes and asking questions. All three of these had statistically significant correlations with students perceived overall experience with the transition and perceived impact of online instruction on their learning. As Table 1 indicates, feeling it was easier and safer to ask questions after the transition was moderately positively correlated to having positive perceptions of the transition experiences and the impact of the online instruction on their learning. In contrast, attending fewer classes was moderately negatively correlated to these perceptions; feeling less motivated to learn was highly correlated to these perceptions.

Table 1. Correlation between changed learning motivation and behaviours and overall perceptions of the online transition

	Perception of the experience with the transition	Perception of the impact of online instruction on student learning
Felt less motivated to learn after the transition	-.52**	-.60**
Attended fewer classes after the transition	-.37**	-.40**
Felt it was easier and safer to ask questions in an online learning environment	.42**	.49**

**$p < .001$. The Spearman's rho test was used.

The quantitative data showed that after the online transition, the majority of the students (77% of the survey respondents) agreed or strongly agreed that they felt less motivated to learn. As reported earlier, the reasons for the decreased motivation were related to the changes in ways of teaching and learning and associated challenges after the online transition for some students, and to the changed living and study conditions (often with families) for other students or due to the combination of all these factors.

In terms of learning behaviours, over three-fifths of the respondents (63%) agreed or strongly agreed that they attended fewer classes after the transition; this seemed to be partly a result of their decreased motivation and partly due to the availability of recorded lectures, as student comments below revealed.

> *"…It is also less motivating to attend online classes than in person. It is also more distracting to sit on your laptop with notifications. Whereas in class, you focus at the professor in front of you out of respect, and your peers are focused so you feel the need to also pay attention the entire time."*

> *"I found I was less motivated to attend lecture when I could view online lectures, but the online lecture format allowed me some more time to write notes and properly absorb the material."*

In addition, over half of the respondents (56%) agreed or strongly agreed that they felt it was easier and safer to ask questions in an online learning environment. Similarly, as alluded to in the student comments reported in Section 2, being able to ask questions easily made some students enjoy online learning.

Significant Group Differences

While no statistically significant difference was detected with respect to motivation for learning, significant differences in learning behaviours were found among students by year of study, program of study, race, and residential status (i.e., international or domestic student).

- Class attendance after the online transition differed by year of study, Kruskal-Wallis $H(3) = 27.87$, $p < .001$. *Year 1 students* appeared to be most likely to attend fewer classes after the transition among students in all years for comparison (Figure 6).

- Class attendance after the transition also differed by program of study, $H(3) = 15.53$, $p < .05$: *Engineering Science and TrackOne students* were most likely to attend fewer class whereas *Chemical Engineering students* were least likely to do so after the transition (Figure 7). In addition, perceived ease of asking questions online differed by program of study, $H(3) = 17.50$, $p < .05$. *TrackOne students* were most likely to feel easier to ask questions in an online learning environment while *Engineering Science students* were least likely to feel so.

- Perceived ease of asking questions in online differed by race, $H(3) = 23.02$, $p < .001$. Among the five racial groups included in the comparison analysis, *East Asian (excluding Chinese) and South Asian students* were most likely to feel it was easier to ask questions in an online learning environment whereas *White students* were least likely to feel this way (Figure 8).

- Perceived ease of asking questions online also differed by residential status, Mann-Whitney $U = 30110$, $p < .01$. *International students* were more likely than domestic students to feel it was easier to ask questions online; this is presumably related to the previous bullet; international

students in the sample consisted of higher proportions of Chinese and South Asian students and a lower proportion of White students than did the domestic students, X^2 (4, N=549) = 43.96, p < .001. This implies that the online learning environment tended to benefit the learning of international students in some ways.

Figure 6. "I attended fewer classes after the transition to online learning: Difference by year of study": Difference by year of study

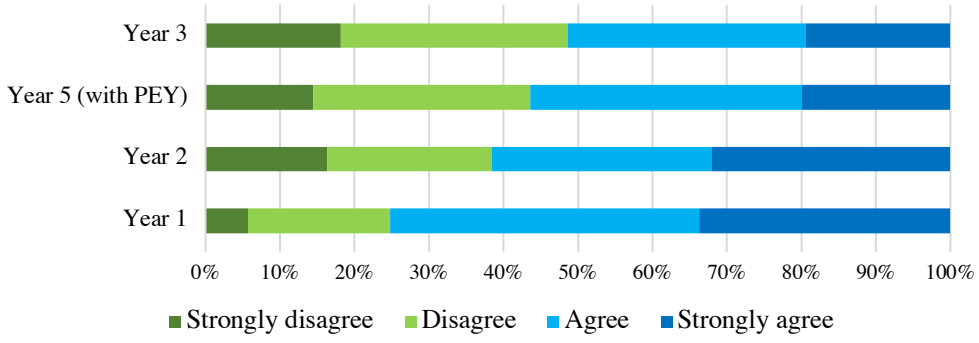


Figure 7. "I attended fewer classes after the transition to online learning: Difference by program": Difference by program of study

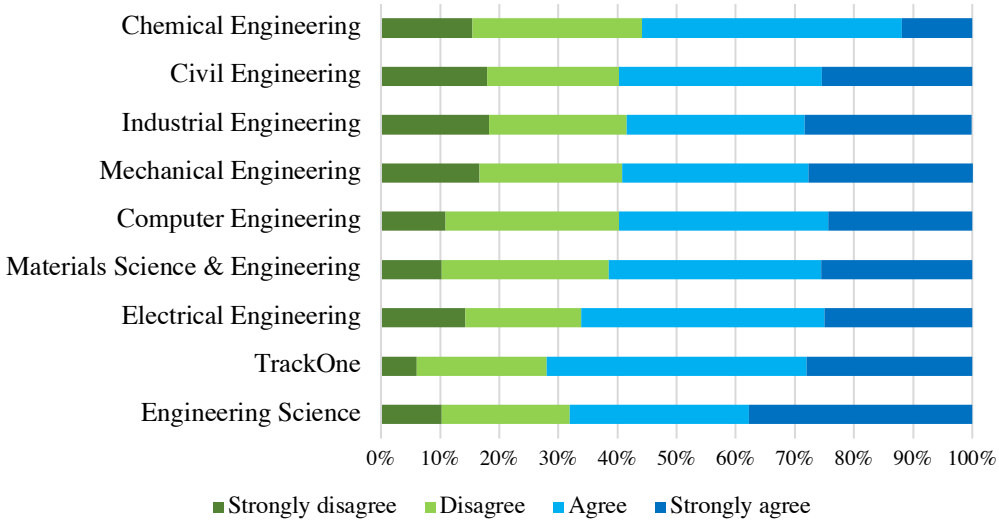
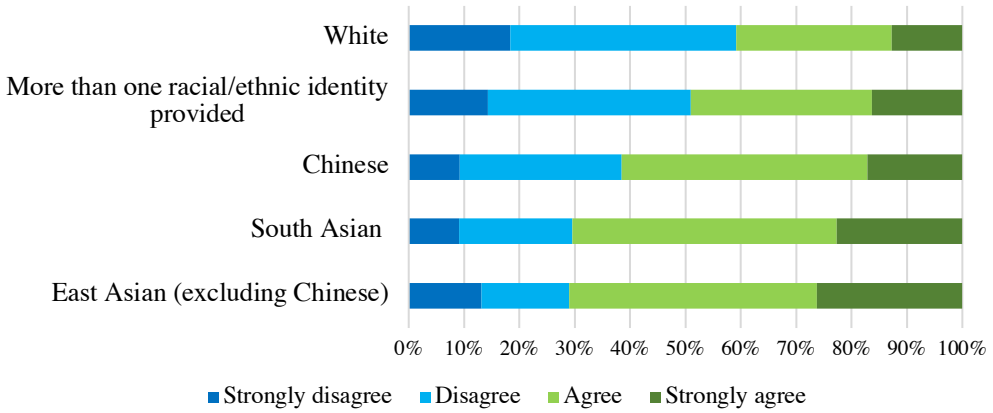


Figure 8. "I felt it was easier and safer to ask questions in an online learning environment": Differency by racial identity



4. Experiences with Online Courses

Two sets of questions were asked about student experiences with online course delivery: one set on perceived challenges; and the other on perceptions of online teaching techniques.

4.1 Perceived Challenges in Online Learning

About half of the total respondents felt substantial challenges (indicated by "quite a challenge" and "a huge challenge") in collaborative learning (i.e., a and b in the table) and class participation in the online environment (i.e., c); and about two-fifths indicated having substantial challenges in delivering online presentations and conceptual understanding of course materials (i.e., d and e) (Table 2).

Table 2. Perceive challenges in online learning

	n	Not a challenge	Some challenge	Quite a challenge	A huge challenge	Quite a challenge or a huge challenge
a. Learning with less interaction with my classmates	783	22%	25%	27%	27%	54%
b. Coordinating teamwork among peers (including team projects)	718	19%	32%	27%	23%	49%
c. Participating in online classes as much as I would in-person	764	29%	22%	24%	25%	49%
d. Delivering online presentations	568	26%	34%	22%	18%	40%
e. Understanding course materials during online class sessions	785	20%	42%	27%	11%	39%

The results are arranged in the descending order of "quite a challenge or a huge challenge."

In addition, **class size** mattered in online course delivery: 55% of the respondents (n=530) who responded to the question agreed or strongly agreed that they found online learning more difficult in large than small classes.

Student Comments on Challenges in Online Learning

In the survey, students were asked to comment the challenges they had experienced with online learning. These comments suggested that **lack of in-person interactions** detracted from student learning. Many respondents commented that the lack of in-person interaction inhibited timely responses to their questions due to back-and-forth email communication and piazza posts; and made it difficult to convey ideas effectively without the opportunity to use the body language or sketch out ideas. Thus, they felt a decreased access to feedback from instructors and TAs.

> *"Having a TA looking over our shoulder to point out an error in less than 3 minutes turned into hours of back and forth over Piazza or similar forums."*

> *"I didn't go to online office hours because I was not sure if was able to explain my doubts and questions properly. It was easier to talk to the professor or TA face to face because I can show him/her my notes or explain what I want to say with body language."*

Students also reported **difficulties with group work** because some felt unwilling to communicate online, and scheduling meetings was challenging due to time zone differences, and difficulty in establishing relationships with students they had not previously met.

> *"Even in ideal circumstances with conference calls and aligned time-zones, working collaboratively on reports or code takes longer."*

> *"Teamwork was more difficult as teams were less willing to communicate (me included). This is due to the side effect of not seeing the team in person."*

Below is a quote about a student's **challenge in understanding course materials**.

> *"I think I had a harder time grasping concepts and focusing on lectures outside of the classroom environment. I feel as if I didn't learn nearly as much or spend enough time on the coursework, though this was purely psychological as I had a very accommodating working environment at home."*

Significant Group Differences

Statistically significant differences were found among the following student groups:

- Significant differences by year of study were detected in perceived challenges in understanding course materials in online learning (Kruskal-Wallis $H(3) = 18.75$, $p < .01$) and class participation ($H(3) = 11.83$, $p < .001$): *Year 5 students* were least likely and *Year 1 students* were most likely to view these areas as challenging (Figure 9).
- Significant difference by program of study was found in perceived challenge in coordinating teamwork among peers, $H(3) = 17.12$, $p < .05$. Among the eight programs for comparison, *Civil Engineering students* were most likely to feel the challenge in coordinating teamwork (Figure 10).

- *Students who registered with Accessibility Services* were more likely than those who did not, to perceive understanding course materials during online class sessions to be more challenging, Mann-Whitney $U = 10436, p < .01$.

Figure 9. Perceived challenge in online learning: Difference by year of study

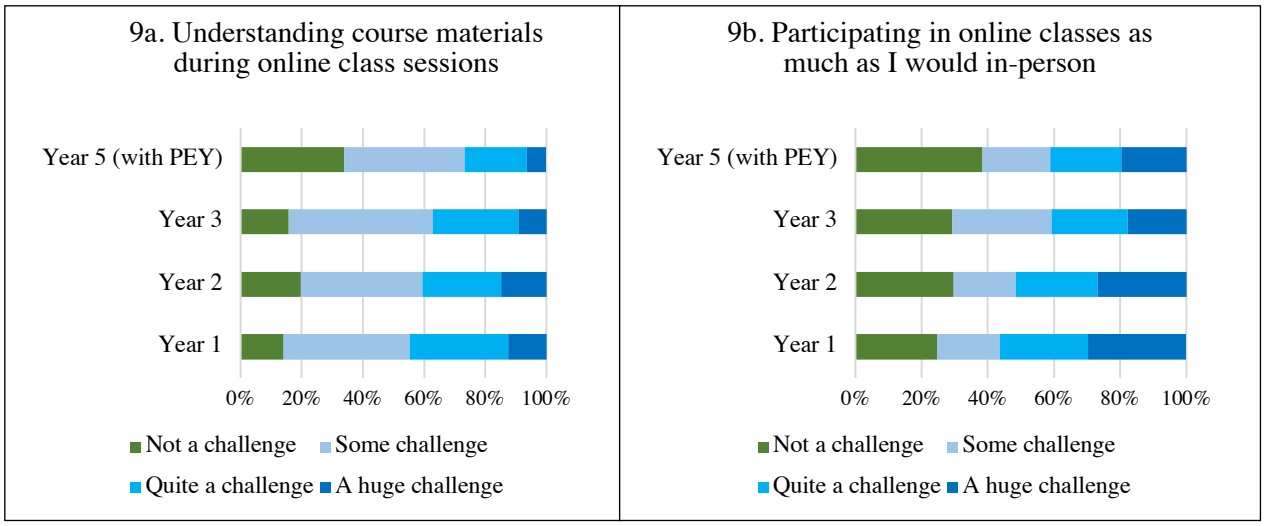
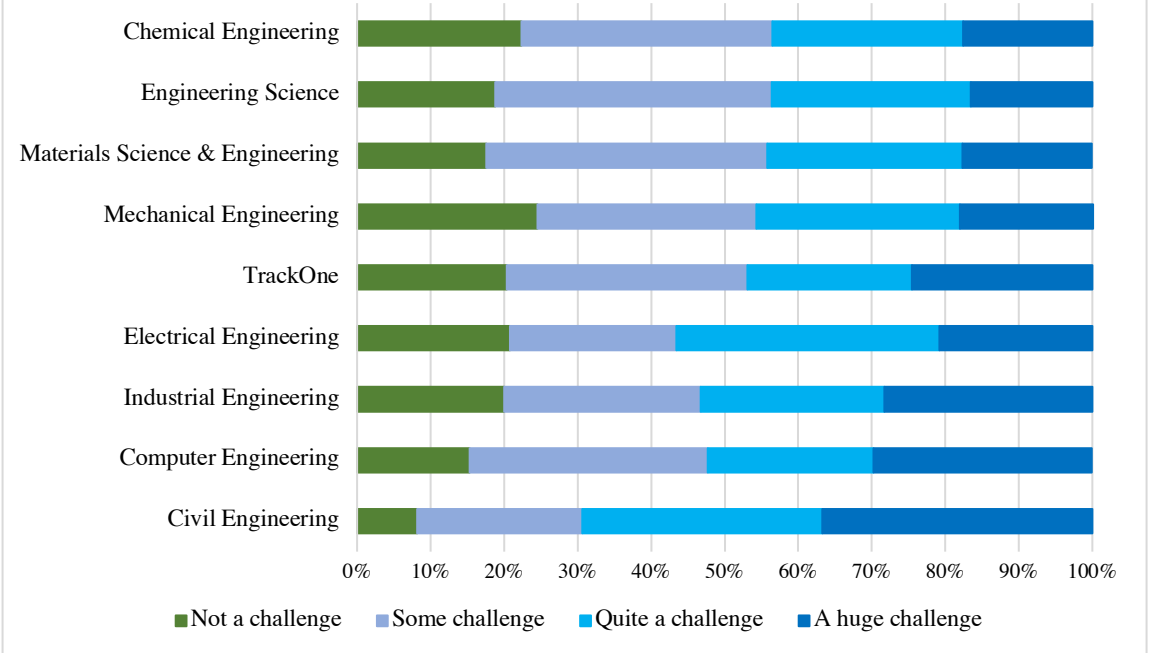


Figure 10. Coordinating teamwork among peers (including team projects): Difference by program of study



4.2 Perceptions of Online Teaching Techniques

In the survey, students were asked to rate how much nine online teaching techniques helped them learn.

Among the five in-class techniques, the top two that the vast majority of students found helpful or very helpful involved use of recordings (either pre-prepared or created from live class sessions) (i.e., a and b in Table 3); synchronous classes (i.e., c) and use of the inverted classroom approach (i.e., d) were helpful to around three-fifths of the respondents; and the use of breakout groups in online teaching (i.e., e) was helpful to nearly two-fifths of the respondents.

Regarding outside-class techniques used to support learning, the respondents were more likely to find online submission available for assignments and quizzes, and online feedback (i.e., f and g in Table 3) helpful than online discussion forums and online office hours (i.e., h and i).

Table 3. Perceptions of online teaching techniques

	n	Unhelpful	Somewhat helpful	Helpful	Very helpful	Helpful or Very helpful
In-class techniques						
a. Instructor recorded live class sessions and then posted them for student use after class	745	3%	10%	24%	63%	87%
b. Instructor pre-prepared course content recordings and then shared them with students during online class sessions	671	8%	20%	35%	37%	72%
c. Instructor ran online class sessions in real time	746	11%	24%	36%	30%	65%
d. Instructor posted content prior to the class and used the online session to answer questions and elaborate concepts	555	16%	26%	32%	26%	58%
e. Student breakout groups in online class sessions	410	33%	30%	21%	15%	37%
Outside-class techniques						
f. Online submission available for assignments and quizzes	786	5%	13%	34%	49%	82%
g. Instructor provided feedback online on assignments or presentations	602	6%	20%	39%	35%	74%
h. Online discussion forum (e.g. Piazza, Quercus discussion board, Teams)	664	7%	26%	28%	38%	66%
i. Online office hours	506	13%	24%	35%	28%	63%

The results are arranged in the descending order of "Helpful or Very helpful."

Student Comments on Online Teaching Techniques

Student comments provided explanations for how the students perceived the use of online teaching techniques listed in the survey. As reported below, the pattern that emerged from these comments generally aligned with what was found in the quantitative data shown in Table 3.

More than half of the student comments on favorite teaching tools or strategies referred to instructors posting recordings, whether the recordings were pre-prepared lectures or live classes. Many students preferred recorded live classes, with recordings posted shortly after class, but some students preferred pre-recorded lectures. An issue with live class sessions that students mentioned was that live classes could be a challenge for students in a different time zone, particularly for those with a 12-hour difference. For re-recorded lectures, some students found it hard to ask questions in a timely manner and others found that when watching these lectures, it was easy to become distracted and demotivated, and they missed interaction with their peers and professors.

Many students mentioned that these recordings made it easy for them to review material, view difficult sections multiple times, and allowed them to view a lecture at a different time or in a different time-zone for some. Student also made recommendations for videos, such as including (but not depending on) videos from external sources, having shorter sections within longer videos, using close-caption, showing Powerpoint slides and the instructor's face simultaneously, making the speed variable, not talking too fast, and incorporating animation and/or drawing where possible. Below is a quote that illustrated an exemplar.

> *"My favorite tool was were the professor posted pre-recorded lectures all on one single page, with clear instructions on what order to watch them in at the same time each week. Then in addition, made himself available to ask questions on piazza and posted his written notes online prior to each of the videos that were posted. The expectations were clearly explained to the class and the videos were easily accessible and laid out in an intuitive manner."*

Many students favoured live class sessions, which they felt resembled the dynamic of classroom lectures and allowed them to ask questions in the moment, verbally or through a chat window. Many mentioned that having a TA who monitored questions received through the chat function was very helpful in live class sessions. Some suggested making lectures more interactive through quizzes, polls, and online labs.

> *"Having the lecture during the scheduled time (live) was much more beneficial for me because it mimicked the closest thing I had to a university lecture room/ learning setting. When I could write my notes as my professor was explaining concepts it made it easier to go and read the notes later on. I had more motivation to go to class when it was "live", versus when I would watch pre-recorded videos at my own time."*

Some students preferred the inverted classroom approach, by which the instructor had provided pre-recorded lectures and used the class time for questions and answers. The main issue reported about the approach was that students felt that it took them more time in total (pre-recorded lecture and live class session), thus increasing how they felt about workload for learning the same content. Some students commented that they liked the quizzes they had to complete prior to the live class about how well they understood the material from pre-prepared recordings. Below are two quotes that show how two students perceived the inverted classroom approach differently.

> *"I believe a happy medium is an inverted model where the videos/material is posted beforehand for students to go through, a summary lecture (1-2 hrs) of what was covered in the week, highlighting the most important concepts, and an office hour session (1-2 sessions) for students who have questions."*

"In another course, lectures were pre-recorded and then the normal in-person hours to answer questions about those lectures. However, pre-recoding the lectures and then also adding regular lecture hours' worth of office hours effectively doubles the hours required by the course."

Posting slides or notes that accompanied lectures was also a popular strategy. However, some students felt that they had trouble learning when instructors posted lecture notes without providing live sessions to explain and clarify course material. Moreover, students preferred instructors to post their own content and to only use textbook readings/external sources as supplementary learning resources. Some students did not favor that instructors simply narrated over their notes without writing their notes out and explaining the concepts in the moment. They commented that the narration also led instructors to speed up their delivery and reduced the likelihood they would check in with the class for understanding.

For some students, breakout groups were not so helpful because they felt that students were generally hesitant to contribute their ideas, especially when there was a lack of supervision.

"The student breakout groups weren't very effective, as students weren't very confident to share their ideas. Their videos and sometimes audio were off and they always waited for someone else to chip in knowing they can hide behind their computer screens. Maybe create a way to choose who has to speak during discussion so everyone's input is provided."

"The breakout groups were not helpful, most of the time students didn't really speak in them and it was awkward silence"

In terms of teaching tools, many favoured BB Collaborate on Quercus, as shown in the quote below; and some also liked question boards, online discussion boards and break-out rooms. Some students asked for improving the quality of recordings by reducing background noise and adding speed control and offline features.

"My favourite teaching tool used was when the prof used BBcollaborate during our original lecture time. It brought a sense of normalcy and kept me on task and focused. He recorded it so students with different time zones could access it."

In terms of the techniques used outside class to support student learning, students appreciated online group office hours and tutorials in which instructors and TAs used audio and video (not just typing in the chat box); and particularly prized one-on-one sessions with instructors.

Students reported that the difficulty with discussion boards lied in slow responses from instructors and greater chances for miscommunication in an online environment, compared to in-person interactions. They recommended that discussion boards and chat questions be monitored so that their questions could be answered as promptly as possible.

"My main concern is having clarifications for questions I may have with the course content. If a professor offers face-to-face office hours (e.g. on BB Colab), I find myself to be able to comprehend the material much better. I can't emphasize how much impact this has made on my learning in the last term."

"An online discussion forum with dedicated TA to answer questions from assignments is also helpful since instructors don't have time to answer all the questions students have."

Significant Group Differences

Statistically significant differences by year of study and program of study were found in perceptions of some of online teaching techniques.

- Some online teaching techniques appeared to be more helpful to students of one level than to students of another. For example, there was a significant difference by year of study in student perceptions of the technique of posting recordings of live class sessions for student use, Kruskal-Wallis $H(3) = 19.00, p < .001$: *Year 3 students* were most likely to find the technique to be helpful while *Year 1 students* were least likely to find it helpful (Figure 11a). *Students in upper years (Years 3 and 5)* were also more likely than those in lower years (Years 1 and 2) to find real-time class sessions and online submission available for assignments and quizzes to be helpful, with $H(3) = 8.55, p < .05$, and $H(3) = 16.79, p < .01$, respectively. In contrast, *Year 1 students* were more likely than those in other years to find the online discussion forum to be helpful (Figure 20b), $H(3) = 12.53, p < .01$ (Figure 11b).

- Two online teaching techniques appeared to be more helpful to students of some programs than to their peers of other programs: use of pre-prepared recordings, with $H(3) = 23.72, p < .01$, and online discussion forum, with $H(3) = 36.64, p < .001$ (see the program differences in Figure 12, arranged in the ascending order of mean ranks).

Figure 11. Perceptions of online teaching techniques: Differences by year of study

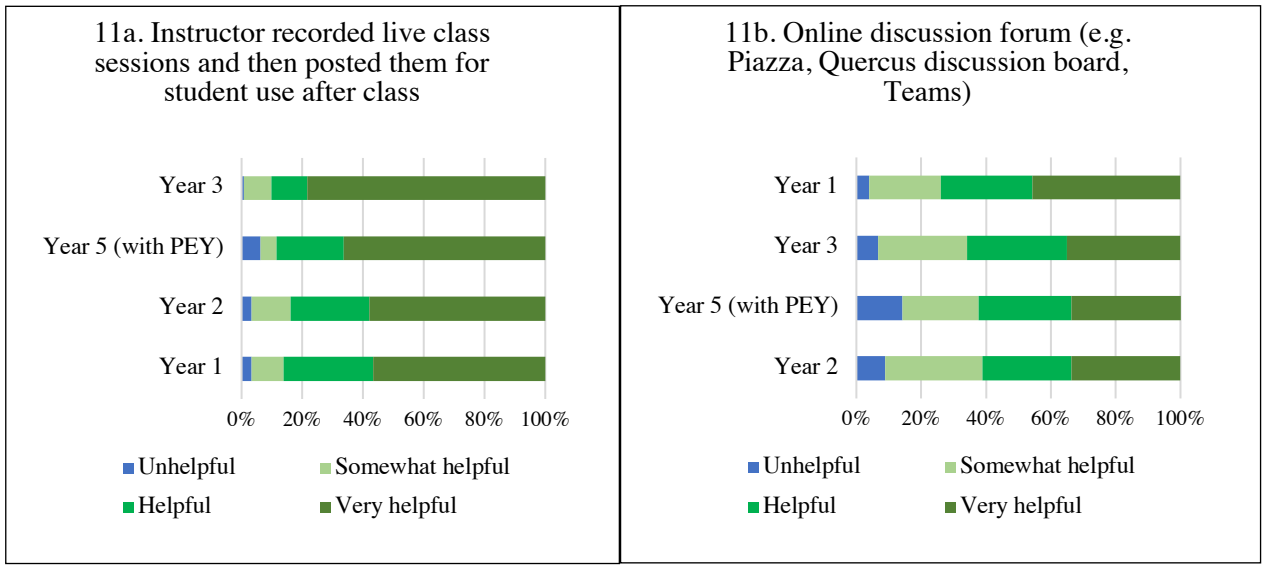
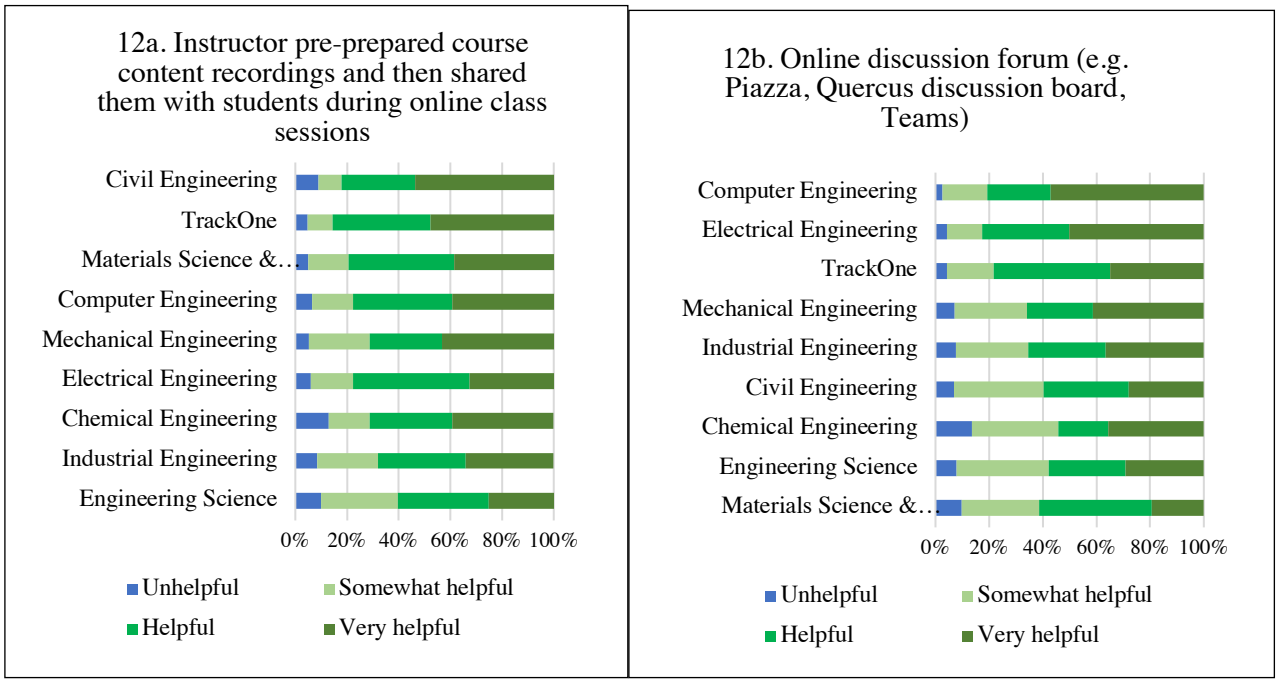


Figure 12. Perceptions of online teaching techniques: Differences by program of study



5. Experiences with Final Assessments

In the survey, students were asked to provide a rating for perceived challenge for completing final assessments and exams and rate four statements on validity and academic integrity related to final assessments. An open-ended question was also asked to probe additional comments about the experiences with the final assessment.

Overall Experiences with Final Assessments

Over half of the respondents (53%) indicated that completing final assignments and exams was a substantial challenge ("quite a challenge" or "a huge challenge") (Figure 13). As shown in Table 4, while almost all the students were aware of and understood the policies on academic misconduct in regards to the online final assessments (i.e., d), 29-40% of the respondents had issues with the validity (i.e., b) and academic integrity (i.e., a and c) associated with the final assessments.

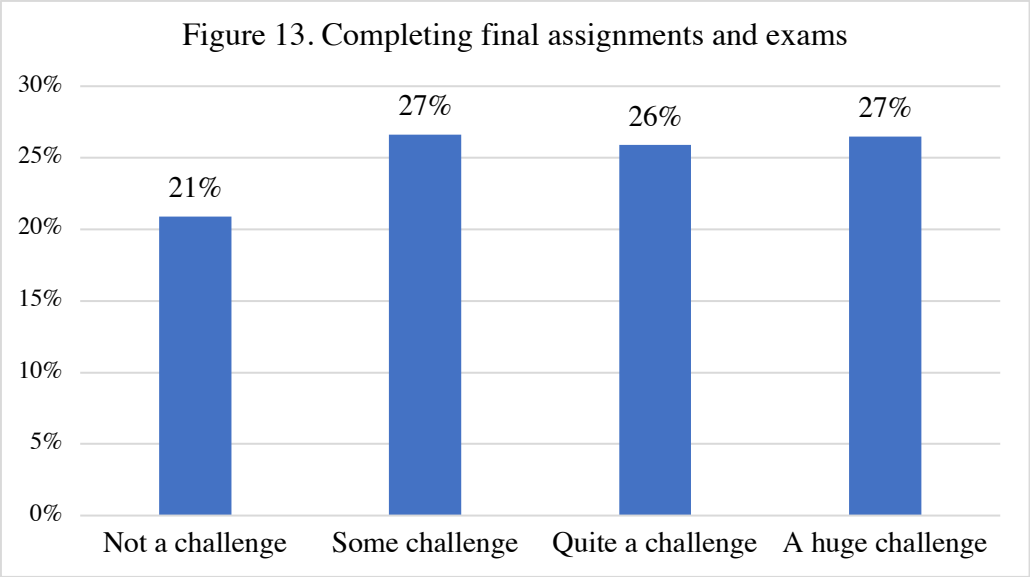


Table 4. Perceptions of final assessments

	n	Strongly disagree	Disagree	Agree	Strongly agree	Strongly disagree or Disagree
a. Final assessment methods discouraged academic misconduct	704	14%	27%	45%	15%	40%
b. Final assessment methods allowed me to demonstrate my learning from the course	772	15%	22%	48%	15%	37%
c. I believe that most of my peers took the final course assessment with academic integrity	681	10%	19%	49%	22%	29%
d. I was aware of and understood the policies on academic misconduct in regards to the online final assessments	781	1%	1%	39%	59%	2%

The results are arranged in the descending order of "Strongly disagree or Disagree."

Student Comments on Assessments

In the survey, students were asked to provide comments about what worked well and what did not work well with their final course assessments. These comments helped explain the results above from the quantitative data.

Students reported they had **positive experiences** with the following assessment methods:

- Open-book exams. Students perceived open-book exams to be a fair way of testing knowledge and ensuring academic integrity. However, some students commented that open-book exams tended to be harder than regular exams or did not help them maintain motivation for learning.

  "I think more tests should have been made explicitly open book, since this would have made it easier to trust that everyone is on a level playing field, without having to employ invasive levels of surveillance."

- Open-ended exam questions asking for unique problem solutions. Some students also commented that randomized ordering of exam questions was a good method of supporting academic integrity.

  "Having essay response type questions made it very easy to discourage academic misconduct because each "opinion piece" is individualistic."

  "I believe timed final course assessments (2-3 hours) with many assorted random questions worked well in disadvantaging (NOT preventing) students who cheat"

- Take-home assignments or projects, which were often problem or case study-based. Many respondents favoured changing final assessments from exams to take-home assignments or projects, which encouraged students to exercise their critical thinking and helped them better understand the course material.

  "Some courses took advantage of the online format to change the final assessments to design based assignments with full access to resources. These assessments were open ended ensuring academic integrity, while being interesting and helpful to understand the material even better."

  "One course created a brand new culminating assignment/lab which was really interesting and fun to complete where it was more difficult to cheat because of the way it was created."

Students also appreciated instructors who took time zones into consideration when designing exam time windows and used exam formats that allowed students to submit pdfs to show diagrams, problem approaches, or equation steps.

"Flexible time allotments. I think this was a good way to handle the fact that many people have distractions at home, connectivity issues, and may be in different time zones. My final assessments all were at least 24 hours, and I think that was smart"

In contrast, students reported the following **negative experiences** with final assessments:

- Multiple-choice questions. Students perceived exams that used only multiple choice or short answers to be unfair as they encouraged academic misconduct and did not allow for partial marks to demonstrate learning.

  "There needs to be more ways to show your work so you can get part marks, because if you spend 10 minutes on a question and you get the mark based on multiple choice, despite you having done 4/5 steps correctly is unfair."

- Underestimated completion time for final assessments. There were some instances where exams published as taking three hours to complete actually took some students 10-15 hours to finish. A reason for the prolonged completion time was that some students did not have access to a quiet, private space, or consistent wifi or good computers, or current software, or printers and scanners; all these reduced their ability to perform well on exams and upload their papers without problems. In addition, many students reported that some 24-hour exams had higher levels of difficulty than previous exams and covered material that had not been taught in class, thus causing some students to feel increased stress, particularly when there were overlapping assessments within a 24-hour period.

  "2 of my 3 exams were "24hr" exams, where we had a full day to complete them. However, both of these exams ended up taking much longer than 3 hours, which became a major issue as I had overlapping assessments that meant I could not devote as much time as others to the exams, which would have been needed to perform well."

- Unreasonable exam formats. Some students reported that exams did not allow students to view all questions at the beginning, or restricted them to move backwards to review questions; they viewed this as unfair and very different from paper-based exams. These changes prevented students from applying their regular test-answering techniques. This was another factor in assessments that brought students stress.

  "Under a two hours time constraint I had 6 questions and I can only view the next question by submitting the previous one - gave me no chance to change my answer and skip any question that I don't know what to do. Consequently, I wasn't able to finish questions that I actually know how to solve since I didn't have time to even view the question."

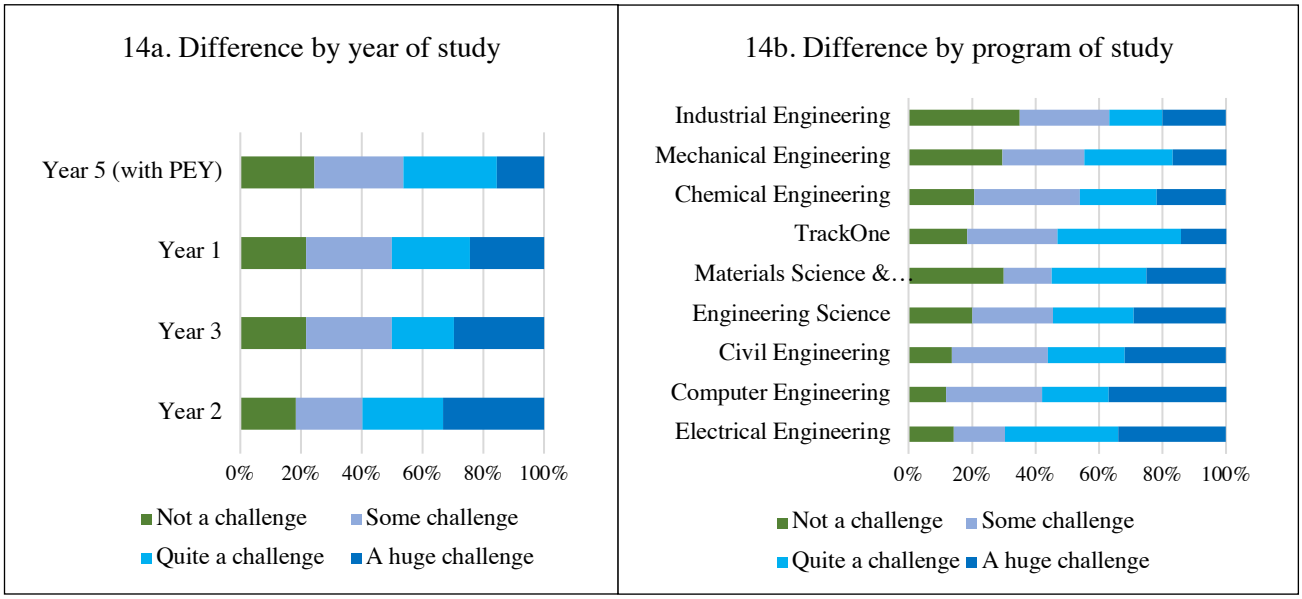
Significant Group Differences

The following statistically significant differences were found in the perceived challenge in completing final assignments and exams:

- Significant difference by year of study, $H(3) = 10.55$, $p < .05$: *Year 5 (with PEY) students* were least likely to perceive the challenge whereas *Year 2 students* were most likely to do so (Figure 14a).

- Significant difference by program of study, $H(3) = 27.02$, $p < .01$: *Industrial and Mechanical Engineering students* were least likely to perceive the challenge whereas *Electrical and Computer Engineering students* were most likely to do so (Figure 14b)

Figure 14. Perceived challenge in completing final assignments and exams: Group differences



In addition, the following statistically significant group differences emerged from a set of comparison analyses in terms of perceptions of the validity and academic integrity associated with the final assessments.

- Significant difference by year of study was found in the perception of the validity of final assessments, $H(3) = 10.59$, $p < .05$: *Year 2 students* were least likely to agree with the statement that "Final assessment methods allowed me to demonstrate my learning from the course" (Figure 15).
- Significant differences by program of study were also found in the perceptions of the validity of final assessments, $H(3) = 35.37$, $p < .001$, and the academic integrity in final assessments $H(3) = 36.45$, $p < .001$. Figure 16 shows that *Computer Engineering, Electrical Engineering and Engineering Science students* were more likely than others to have issues with these areas of final assessments.
- *Women* were more likely than men to feel completing final assessment was challenging, $U = 47546.5$, $p < .01$; and more likely to agree that final assessment discouraged academic misconduct, $U = 37987.5$, $p < .01$.
- Significant difference by race was found in the perception of the academic integrity in final assessments the statement, $H(4) = 10.33$, $p < .05$: White students appeared to be more positive than East Asian students about the statement "Final assessment methods discouraged academic misconduct."

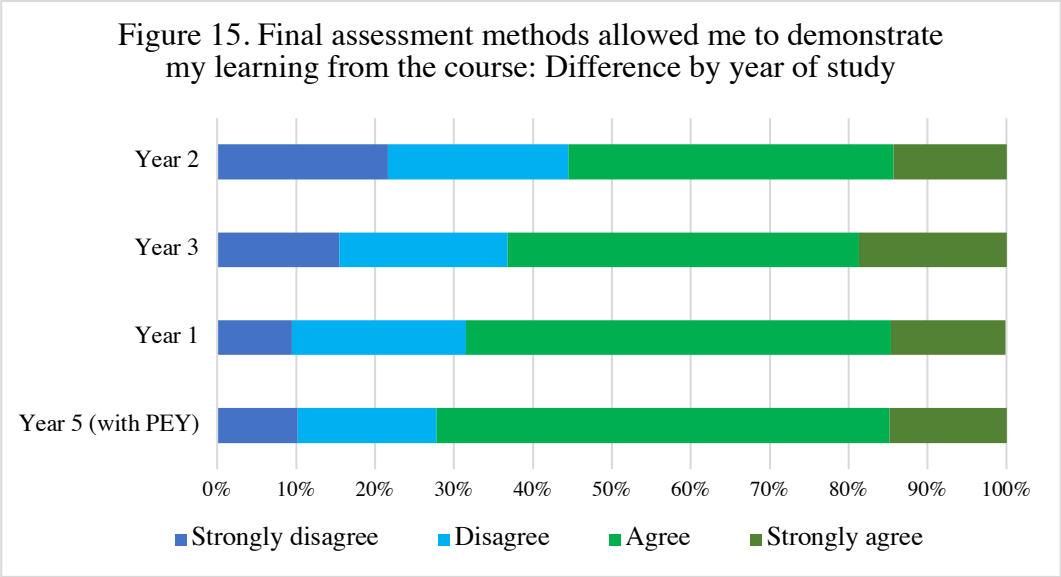
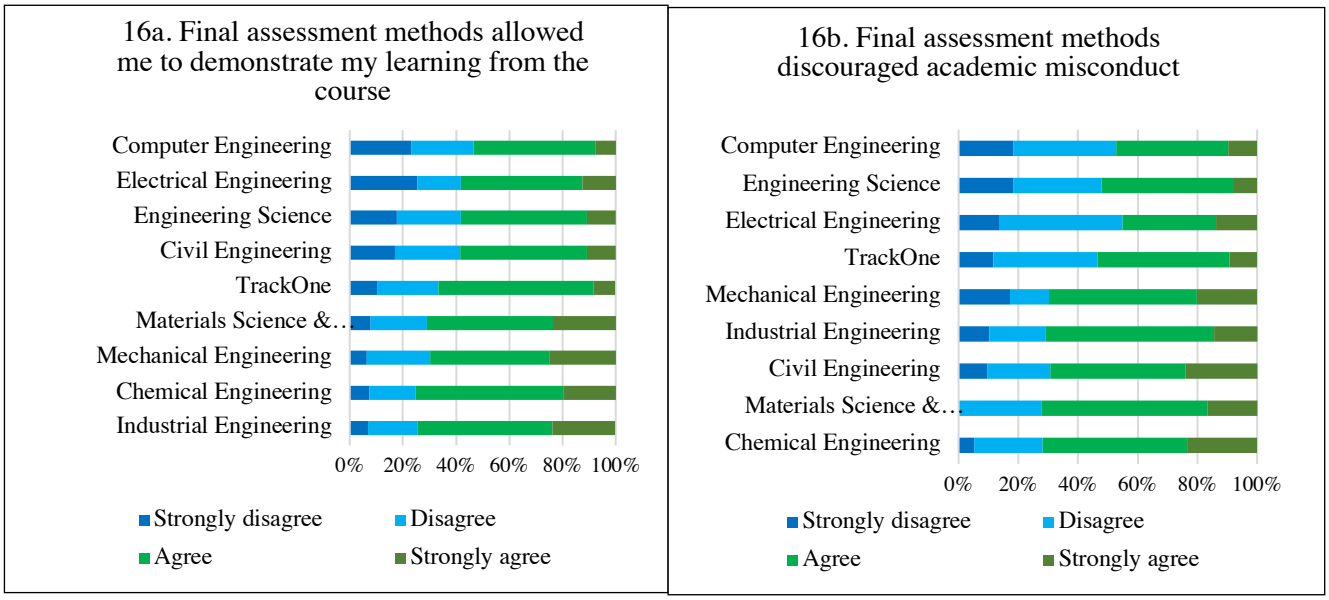


Figure 16. Perceptions of final assessments: Differences by program of study



6. Perceived Academic Workload

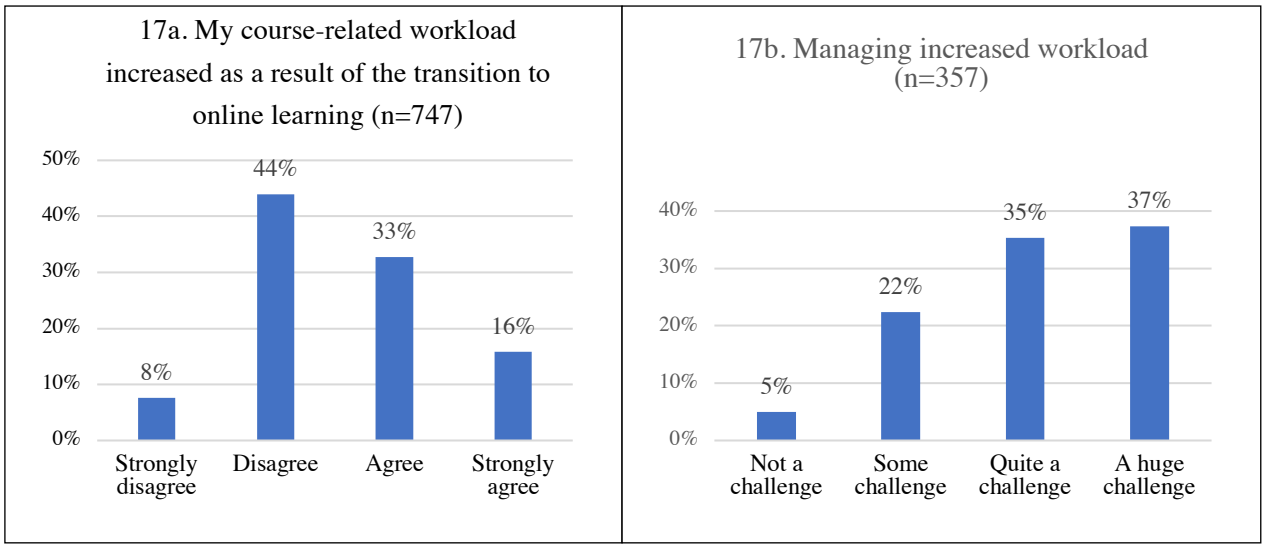
In the survey, two questions were asked to probe students' perceptions of their academic work. In addition, some of the student comments on a set of perceived challenges referred to academic workload.

Overall Perceptions of Academic Workload

The overall perceptions of academic workload were mixed. While nearly half of the respondents (49%) indicated that their course-related workload increased as a result of the transition, the other half did not, as shown in Figure 17a. Further, of the 357 respondents who felt that workload increased, 72% indicated

that managing the increased workload was a substantial challenge (measured by "quite a challenge" and "a huge challenge" in Figure 17b).

Figure 17. Perceptions of academic workload



Students' perception of increased workload did not relate much to the number of courses they took during the term, $H(4) = 9.34$, $p = .053$, neither did their perceived challenge in managing increased workload, $H(4) = 3.36$, $p = .50$. This means that the perceived workload differed from the actual workload students had.

Student Comments on Perceived Workload

Students' comments indicated that they perceived an increased workload for **various reasons**, including decreased access to the appropriate technologies, decreased motivation for learning, difficulties communicating for group projects, declining general mental health, changed ways of teaching and learning, or increased responsibilities at home. With these factors intersecting with each other, many students experienced problems managing their workload. The following quotes illustrate different situations among students.

> *"Learning with less interaction was especially difficult for group projects, especially for ones where we needed physical equipment we usually accessed in school labs…this increased the workload for the project because of having to improvise and one person possibly doing the experiment themselves"*

> *"I find that it will be much harder for me to keep up with the academic workload in the term and there will likely be a very negative effect on my grades. Even if I get satisfactory grades I strongly believe that I will be unable to retain a lot of the information since in person lectures is the best way I have been learning. I think that I will also naturally lose many connections I made in first year since I live out of province and have declining mental health."*

"Due to the given pandemic, my mental health became devastatingly worse, which made it incredibly difficult to adjust to the increasing workload. The exams felt harder and I felt I was constantly under pressure even more than I would during in-person university."

Significant Group Differences

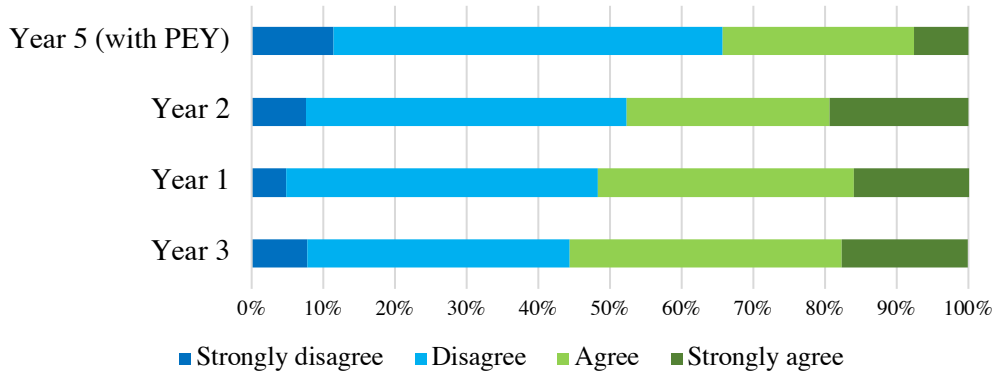
Statistically significant differences by year of study, program of study, and gender[2] were found in perceptions of academic workload.

- The perceived impact of the online transition on students' academic workload differed significantly by their year of study, Kruskal-Wallis $H(3) = 13.47$, $p < .01$. Figure 18 shows that *Year 5 (with PEY) students* were less likely than Years 1 to 3 students to perceive that their workload increased as a result of the online transition. No significant difference was found by year of study in perceived challenge in managing the increased workload.

- The perceived impact of the online transition on students' academic workload also differed significantly by their program of study, $H(3) = 25.43$, $p < .01$. Figure 19 shows that among the eight comparison groups, *Mechanical Engineering and Electrical Engineering students* were the least, while *Civil Engineering students* were the most, likely to perceive that their workload increased as a result of the transition. No significant difference was found by program of study in perceived challenge in managing the increased workload.

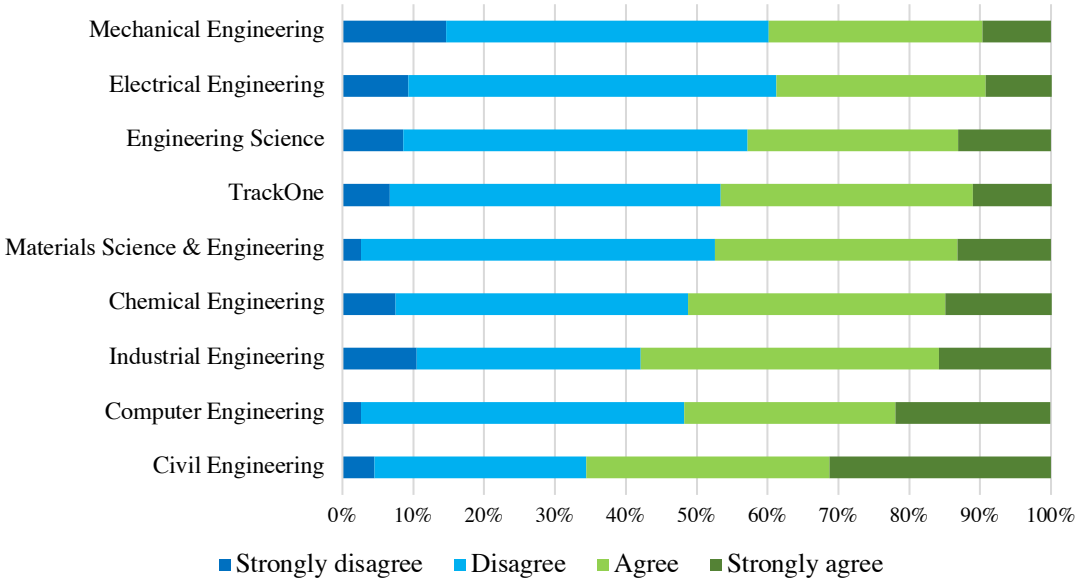
- *Women* were slightly more likely than men to perceive that their workload increased as a result of the online transition, Mann-Whitney $U = 43851$, $p < .05$. Further, perceived challenge in managing the increased workload was also greater for women than for men, $U = 43047$, $p < .01$.

Figure 18. My course-related workload increased as a result of the transition to online learning: Difference by year of study



[2] Only the responses from those who identified themselves as men and women were included in this comparison analysis; responses from students of other gender identities were not included due to small sample sizes.

Figure 19. My course-related workload increased as a result of the transition to online learning: Difference by program of study



7. Access to Online Learning

In the survey, students were asked to provide ratings on perceived challenge through five questions that probed access to online learning. In addition, an open-ended question asked students to explain how they felt that their identity or personal history influenced their experience after the online transition; responses to this question provided information on how family background played a role in students' access to online learning.

Overall Findings on Access to Online Learning

Most students did not experience issues with access to online learning, but a quarter of the respondents felt substantial challenges (indicated by "quite a challenge" or "a huge challenge") in accessing quiet space for attending online classes and resolving technical difficulties with online learning tools, with less than one-fifth reporting substantial challenges in having reliable access to affordable internet and being in a different time zone than the instructor, as shown in Table 5.

Table 5: Perceived challenges in access to online learning

	n	Not a challenge	Some challenge	Quite a challenge	A huge challenge	Quite a challenge or a huge challenge
Having quiet space for attending online classes	794	44%	30%	17%	9%	26%
Resolving technical difficulties with online learning tools (e.g., Quercus)	745	39%	35%	16%	9%	25%
Having reliable access to affordable internet	793	55%	26%	13%	6%	19%
Being in a different time zone than the instructor	612	75%	8%	8%	9%	17%
Having unrestricted access to my own devices (e.g., computer etc.)	788	87%	7%	4%	2%	6%

The results are arranged in the descending order of "Quite a challenge or a huge challenge."

The access-related challenges varied by time zone:[3] compared to the students in Toronto, students who were located in the time zone that is 10-13 hours from Toronto (i.e., China and Japan) were more likely to report challenges in having reliable access to affordable internet (Mann-Whitney $U = 8102.5$, $p < .001$) and having unrestricted access to one's own devices ($U = 11746.5$, $p < .001$); in contrast, students who were in the time zone that is -3 to -1 hours from Toronto (i.e., West Canada) were less likely to report challenges in having reliable access to affordable internet ($U = 13141$, $p < .01$) and resolving technical difficulties with online learning tools ($U = 12036$, $p < .01$).

Student Comments on Access to Online Learning

Student comments suggested that access issues could be significant to some students. It is worth noting that students would lose the prior chat questions and answers each time they became disconnected.

> *"I had to pray that my internet would hold up during the 2 hour live-streamed lecture which was not always the case. When it did not hold up I had to figure out a way of recording what I could because my professor posts recorded lectures of his YouTube livestream but not recorded questions on bbCollaborate. Because I was continually disconnecting and reconnecting, every time I reconnected I lost what my classmates questions were and my professor never repeats the questions so some of the lecture just doesn't make sense due to this lacking of context. It was very frustrating and stressful.."*

> *"my family is very loud by nature and culture. It gets hard to concentrate sometimes and the only place I have to study is my desk. I can't go to the library."*

> *"I am not in Canada. If it is not easy to use VNC in China - it will be a huge problem. Internet problems like using VPN is also a problem."*

[3] Comparisons were made among those who were in Toronto, those who were in a time zone that is – 3 to -1 hours from Toronto (e.g., West Canada) and those who were in 10 to 13 hours from Toronto (e.g., China and Japan) alone. Responses from other time zones were not included for analysis due to the small sample sizes.

When responding to how identity or personal history had influenced their experience, some student suggested that being with a relatively well-off family and having received family support were associated with positive perceptions of student experiences, as shown in the following two quotes.

> *"I felt fortunate that I had a good space to work (have my own office setup at home) and that I have a good relationship with my family. I know some of my friends are not handling being at home 24/7 well due to family problems or lack of appropriate study space."*

> *"My family has a comfortable house in Toronto, with great wifi, and many quiet spaces. I would not have been able to complete my degree this semester had it not been for my family's financial position."*

Significant Group Differences

Statistically significant differences by year of study, residential status, gender and Accessibility Services Registration were found with respect to access to online learning:

- Perceived challenges relating to being different time zones appeared to be greater for Year 1 students than for students in other years, Kruskal-Wallis $H = 14.31$, $p < .01$: 24% of Year 1 students found being a different zone than the instructor to be "quite a challenge" or "a huge challenge." This can be explained by another finding that a lower percentage of Year 1 student respondents (76%) than students in other years (84%-94%) were located in the Toronto area for the majority of the period between March 13 and April 30; and 10% of Year 1 respondents were located in a time zone that is 10 to 13 hours from Toronto (e.g., China or Japan), higher than students of other years (3-5%), X^2 (18, N=778) = 36.81, $p < .01$.

- *International students* were more likely than domestic students to feel the challenges in being a different time zone ($U = 18035$, $p < .001$), having reliable access to internet ($U = 37385$, $p < .01$), and having unrestricted access to one's own devices ($U = 39654$, $p < .01$). This can be partly explained by another finding that 22% of the international student respondents were located 7-9 hours or 10-13 hours from Toronto, in contrast to 1.6% of the domestic student respondents, during the last few weeks of the Winter Term 2020, X^2 (5, N=679) = 99.26, $p < .001$.

- In terms of gender, *women* were more likely than men to feel the challenges in having quiet space for attending online classes, $U = 47054.5$, $p < .01$, and having reliable access to affordable internet, $U = 45377$, $p < .001$.

- Those students who registered with Accessibility Services were more likely than their peers who did not do so to feel the challenges in having quiet space for online learning ($U = 10380$, $p < .001$) and having reliable access to internet ($U = 10547$, $p < .001$).

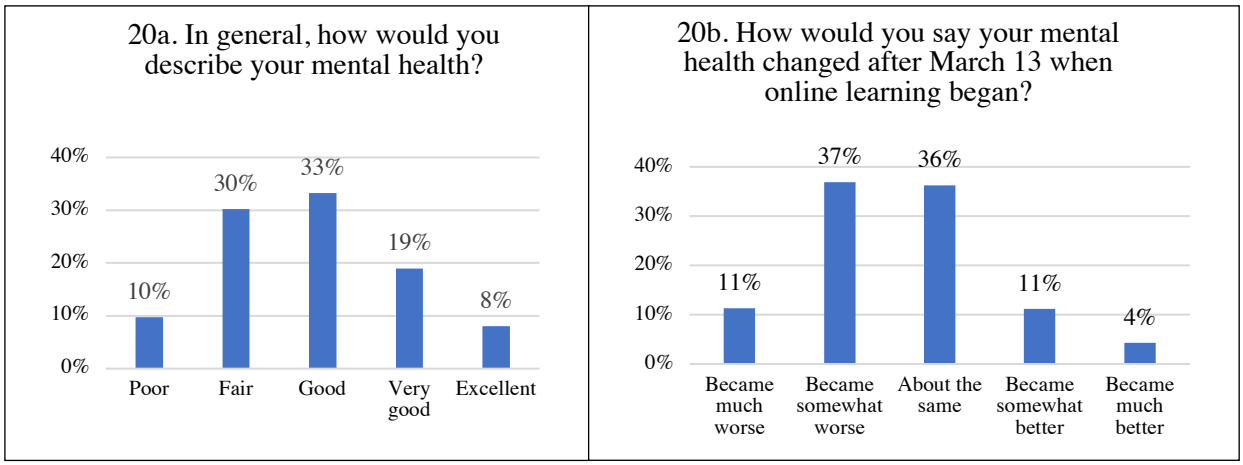
8. Mental Health

In the survey, students were asked about their general mental health and the changes in their mental health after the online transition, and asked to explain what impacted their mental health and what the Faculty could do differently in the fall to help improve the situation. It should be noted that the pandemic, as an external event, could be expected to have a negative impact on student mental health. Given the timing involved, the impact of the pandemic on mental health is intertwined with the impact of transitioning to an online learning environment; and this is reflected in our data.

Mental Health after the Online Transition

Overall, 40% of respondents described their general mental health as poor or fair (Figure 20a); and nearly half of the respondents (48%) felt that their mental health became worse after the transition to online learning (Figure 20b).

Figure 20. Perceptions of mental health



In particular, those students who generally have a poor or fair mental health were more likely to feel the negative impact of the transition than those who have better general mental health. As shown in Figure 21, 79% of those students whose general mental health is poor indicated that their mental health became somewhat worse or much worse; and 68% for those students whose general mental health is fair. Figure 22 shows that 88% of those students whose general mental health is poor reported that they felt quite challenged in responding to the heightened socio-emotional tensions; and 64% for those whose general mental health is fair, in comparison to 50% of the total respondents who indicated so. A Spearman's rho test shows that respondents' mental health was *moderately* positively correlated to the perceived change in mental health after the transition, $r_s = .40$, $p < .001$.

Qualitative data also showed that those with pre-existing mental health conditions found dealing with the pandemic exacerbated their conditions, as illustrated below.

> *"My mental health was already bad before this pandemic, during the school year but after going online my demotivation increased a lot more. And the course load was not helping at all."*

"I was helping my housemates deal with their own mental health due to the loss of schedule, the added stress of online classes, and pre-existing mental health struggles."

"As I am registered with Accessibility Services, and have met friends who are also registered as well, I feel that we generally faced some issues with adapting to the online courses. In my opinion, being separated from peers exacerbates existing conditions, and can make it more difficult to transition."

Figure 21. Influence of the transition on students' mental health: By general mental health level

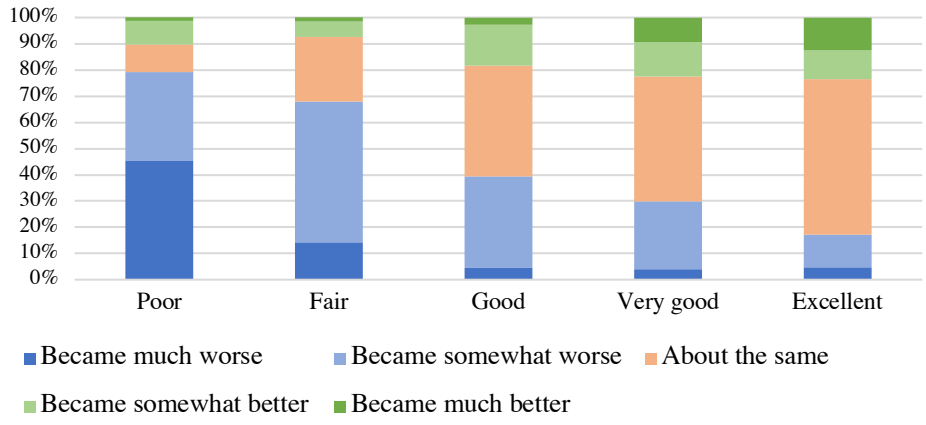
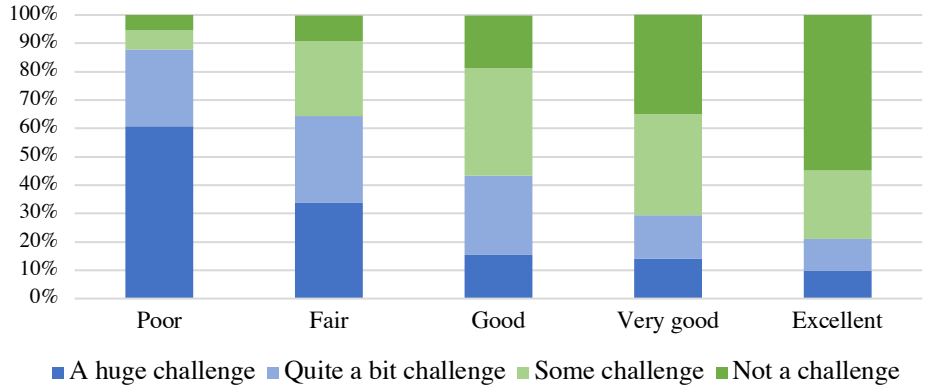


Figure 22. Responding to heightened socio-emotional tensions: By general mental health level



Student Comments on Influencing Factors for Mental Health

When asked about what impacted their mental health, over half of the respondents (54%) provided comments. **Five interrelated influencing factors for students' mental health** emerged from these comments: (1) social isolation and associated lack of motivation, (2) changes in the ways in which courses were delivered and assessed and perception of increased workload in the online environment; (3) deteriorating physical health; (4) lack of social and academic support; and (5) general unfavorable living conditions during the pandemic. These identified factors corroborated with the findings presented in the earlier sections of this report.

Social isolation was mentioned by over a third of the students who provided comments, with the lack of contact with peers being seen as the greatest problem. Students missed the support of their peers both socially and academically. Respondents found it harder to learn in isolation without informal peer-based learning opportunities, missed the interaction before and after classes, and found it difficult to gauge their own performance relative to others. Some reported being unwilling to approach classmates online for fear of being perceived as "time-wasters;" others found instructors less available due to online learning and recorded lectures. Not being able to participate in clubs and sports also reinforced students' sense of social isolation and eroded a sense of community. The absence of social interaction demoralized students and undermined their sense of purpose and motivation. Many reported finding it hard to remain focused without their usual physical school resources and contact with peers and instructors. Some students reported a cycle of **declining motivation** impacting their mental health, which in turn lessened their ability to focus, which in turn left them demotivated.

Online assessments, especially online exams, were a source of anxiety and stress for many students. There was a common perception that some instructors had increased the difficulty of assessments to discourage cheating because they perceived that students had more time available. A number of students reported that the exam session after the online transition was much more difficult than others they had experienced. Some students were concerned that if they did well on an exam or assignment they would be suspected of cheating, while others believed they were being penalized for being honest. Exams that were designed to take 2-3 hours took some students 10-15 hours to complete. Students reported being unable to submit or finish exams on time due to unreliable internet or sub-optimal hardware. **Group work** was perceived as problematic, with students reporting unexplained absences of teammates, struggling to schedule working sessions across time zones, and establishing relationships with teammates that they had not met in person.

Students experienced the negative impact of issues with **course delivery** during the emergency online instruction. They found a lack of consistency in delivery across courses and some complained they were left to teach themselves from textbooks after the transition. Some were concerned that individual instructors had arbitrarily increased their lecture times and consistently ran over time which impacted students' ability to make other lectures on time.

A number of students perceived that course **workload** had increased, with other students perceiving that the workload had remained the same, but that it took more effort and time to complete assignments or coursework in an online environment. Many students reported falling behind during the initial transition period, struggling to catch up, but feeling overwhelmed. General uncertainty about assessment weightings and exam formats added to students' anxiety about coping with their workload.

Many students experienced **physical health** issues. They reported spending significantly more time in front of screens causing problems such as eye strain, backache, headaches and difficulty focusing. Many students reported sleeping less and less as the term progressed in order to cope with their online assessments. A lack of time and campus facilities impeded their willingness and ability to exercise physically and negatively impacted their mental health. Physical confinement, lack of exercise, and absence of routine all exerted negative impacts on students' **mental health**.

Students perceived a **lack of support** to help them deal with their mental health issues. Appointments with counsellors were seen as difficult or impossible to obtain. Some students could not use phone services as they were afraid of being overheard by their parents. While some students used accommodation services, others were uncertain about how to request support. Academically, many students perceived some instructors as lacking empathy and being unwilling to consider any accommodations. Some students pointed out that they were struggling in an online environment as they had no idea how to change their learning techniques to adjust to online learning and had received no formal training on how to make such changes.

In addition, **the general living conditions during the pandemic** negatively impacted students' mental health. A number of students had been forced to return to a home where they had no private space in which to study and lacked reliable internet, wifi, or laptops. A few students reported their home environment as being "toxic" and expressed concern over those students who lived in "unsafe" homes. Some students reported trying to study while being disturbed by other family members and sleeping during the day so they could study at night. Other students were stranded in Toronto after their home country had closed borders and had to cope with living alone and apart from their family and friends during the lockdown. Some students also had to cope with the fact that relations or friends had died or were ill because of COVID-19; others had assumed additional responsibilities and/or financial pressures due to family members losing jobs as a result of the pandemic.

Below are two quotes that illustrate the intertwined factors that influenced students' mental health. Survey respondents reiterated or elaborated on some of the points they already raised when responding to other questions in the survey.

> *"I found that with the increased workload which was being done online (i.e. using a computer) for the greater part of the day was affecting me physically. I think this was because of the repetitive motions and the position that needs to be maintained when using a computer for so long, I had a lot of pain in my wrists and elbows. The increased screen time also affected my eyes and I experience more frequent headaches. This was the other challenge I experienced, which affected my stress levels a lot."*

> *"Difficult family situation, same workload but with poor wifi, stress of COVID, and noisy environment with young children (siblings). I was forced to move out of dorms while studying for midterms. My country had already closed its borders and I temporarily has no place to go. At that point, school was not a priority but rather a mental block of stress."*

Significant Group Differences

Statistically significant differences by gender, sexual orientation, Accessibility Services registration, and race were found in mental health related questions. Women students, LGBTQ students and those who registered with Accessibility Services were more likely to experience mental health related challenges than their respective counterparts.

- Women's general mental health level was, on average, lower than men's, Mann-Whitney $U = 41544$, $p < .001$ (Figure 23a); and *women* were more likely than men to report that their mental health declined after the online transition, $U = 47635$, $p = .001$ (Figure 23b).

- LGBTQ students' general mental health level was, on average, lower than straight students', $U = 12529$, $p < .001$ (Figure 24a); and *LGBTQ students* were more likely than straight students to report that their mental health declined after the online transition, $U = 17455$, $p < .05$ (Figure 24b).
- On average, the general mental health level was lower among those students who registered with Accessibility Services than among those who did not, $U = 8711$, $p < .001$ (Figure 25a); and *those who registered with Accessibility Services* were more likely than those who did not to report that their mental health declined after the online transition, $U = 10107$, $p < .001$ (Figure 25b).

There was also a statistically significant difference among compared racial groups in the perceptions of the challenge in responding to heightened socio-emotional tensions, $H(4) = 19.15$, $p < .01$: Chinese students were *less likely* to indicate such a challenge than East Asians (excluding Chinese), White students, those who had more than one racial identity, and South Asians.

Figure 23. Mental health levels: Difference by gender

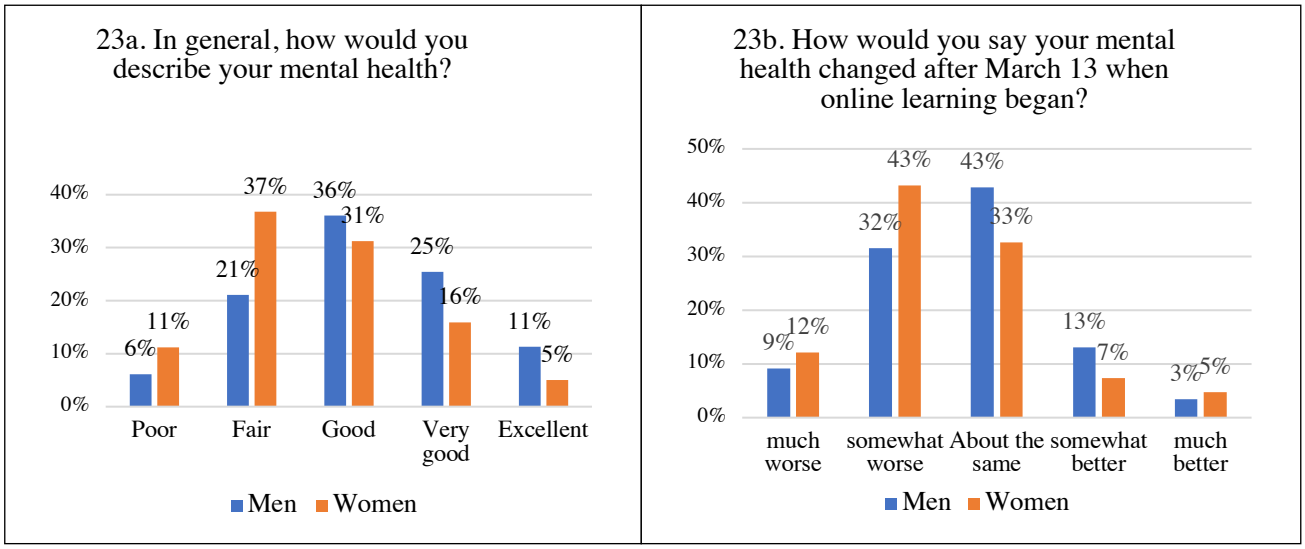


Figure 24. Mental health levels: Difference by sexual orientation

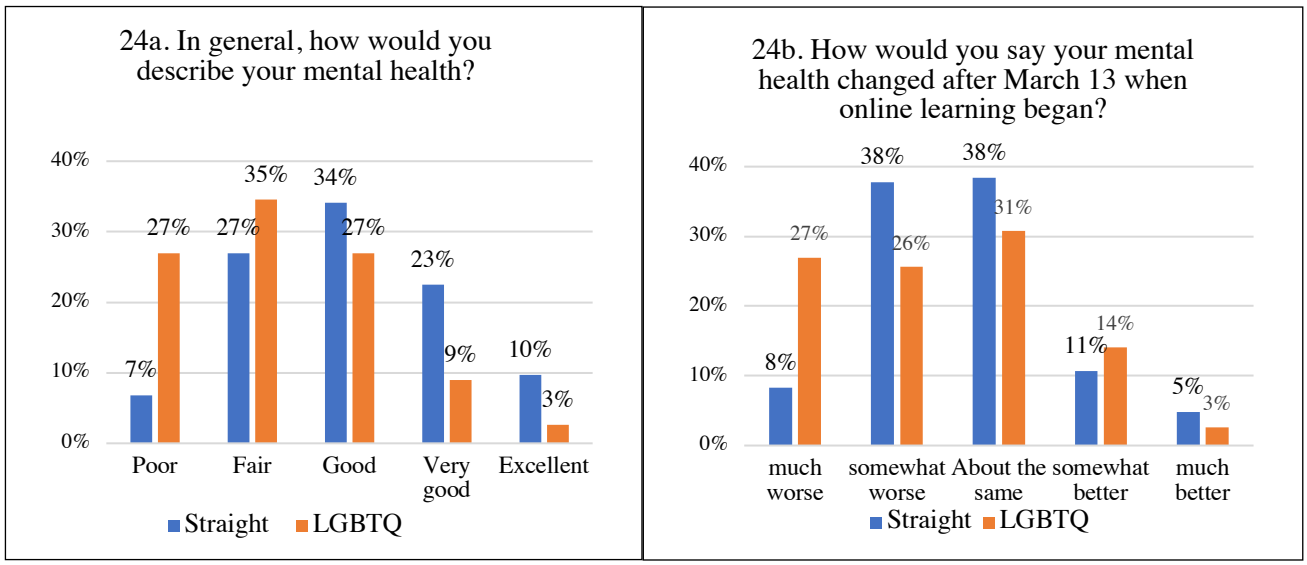
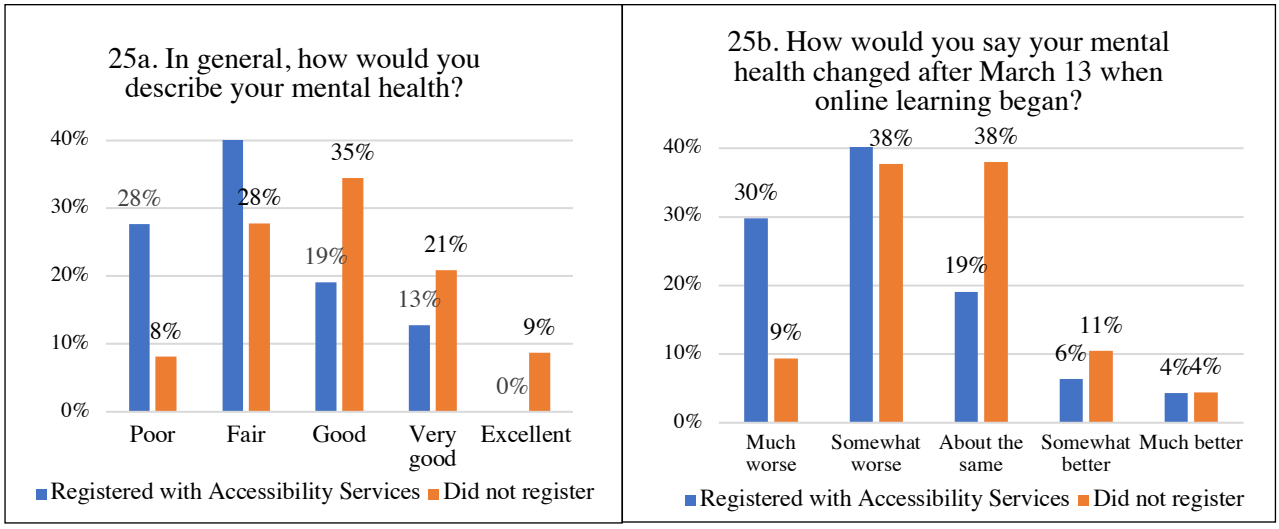


Figure 25. Mental health levels: Difference by Accessibility Services registration



9. Perceptions of Future Online Learning

In the survey, students were asked to explain what challenges or benefits they foresaw for the possible online instruction in fall 2020; and to provide recommendations to help improve their learning experiences in the fall.

Perceived Challenges and Benefits

The student comments on challenges and benefits reflected four themes: (1) continued social isolation; (2) absence of labs or hands-on activities; (3) a lack of motivation or focus; and (4) difficulties accessing technology and online learning.

Students were very concerned about **continued social isolation**. The most commonly cited worry was not having contact with, and support from, their peers as many noted that they learnt from their peers and depended on them in times of stress and uncertainty. Many students considered relationships built in the first year as especially important and worried that it would be difficult for the incoming first year students to establish these relationships and a sense of community while abiding by social distancing rules. In addition, there were concerns about the lack of contact with faculty, instructors and TAs, from both personal and academic perspectives. The lack of access to physical spaces such as libraries, gyms, and labs was also seen as very problematic as was the loss of social and school activities hosted by engineering teams and clubs.

Many students were concerned about the **absence of labs** and the challenges associated with the completion of capstone courses and other hands-on tasks, which they believed would be difficult, if not impossible, to complete in the online environment.

"As a robotics major, many of the practical hands-on courses I am looking forward to, and which will enhance my undergraduate education overall, will be impossible to run. There is no online substitute to building robots."

"Lab work is a major aspect of chemical engineering and studies will miss out on that learning opportunity if classes are online. The substituted solution required by the accreditation board may be less effective and more difficult to fulfill by students."

Many students noted that they had found it **difficult to remain motivated** for the portion of the spring term that was online and anticipated an entire online fall semester to be proportionally more difficult. Students mentioned their motivation being negatively impacted by the sheer volume of online work, the lack of variation in delivery, spending hours on end in front of a computer without breaks, lack of contact with their peers and instructors, being unsure how to study in a purely online environment, not having a quiet space or privacy to study.

"I anticipate a sharp drop in my GPA. What happens to our lab-based courses? The physics option for EngSci has a course that's only has lab hours and no lectures. I also take part in a lot of campus activities including design teams, playing on 3 intramural sports teams, and a campus orchestra. Doing all these other activities motivates me to study. But at home, I'm just rotting away."

A number of students were concerned that the **difficulties accessing technology and online learning** that they had experienced in the spring would continue. These challenges included access to reliable and affordable internet; difficulty connecting to UofT or program file sharing systems; lack of privacy and quiet in their home environments and/or lack of support from family, which exacerbated the technical issues they experienced; and time-zone issues that both international and domestic students found negatively impacted their performance in classes and exams.

In addition to challenges above, some students felt unsure how well they would learn if the learning environment in fall was online. Below are two quotes to illustrate this uncertainty.

"I feel as though starting new courses online will be very difficult for me as it often makes expectations unclear and makes it difficult to know the load of the course or how much work needs to be put into it. Without knowing these, I feel as though I will be floundering and confused as to how to plan my time."

"I find that it will be much harder for me to keep up with the academic workload in the term and there will likely be a very negative effect on my grades. Even if I get satisfactory grades I strongly believe that I will be unable to retain a lot of the information since in person lectures is the best way I have been learning. I think that I will also naturally lose many connections I made in first year since I live out of province and have a declining mental health. I don't foresee any benefits for this."

The **primary benefits** of moving to online education that respondents identified were saving commuting or travel time, safeguarding the health of themselves and the community, and having the opportunity to review recorded material multiple times. Some students commented that they were too shy to ask questions in person, but were comfortable using chat or question boards to do so. Students who preferred online learning cited the flexibility in when and how they learned, found it easier to ask questions, preferred open book exams and found it easier to demonstrate the knowledge learned. Some of these students noted that their mental health had improved after the shift to online. Many noted that recorded

lectures helped them study at their own pace and allowed them to revisit concepts to clarify concepts covered in class.

Students anticipated spending the time previously used for commuting on studying or working to support themselves and/or families. International students anticipated saving time and money by not having to rent accommodation and pay for travel to and from Canada. Some students also were happy to spend more time with family.

> *"A benefit would be eliminating commute time to the university and would allow me to avoid the subway system altogether."*
>
> *"I really did enjoy being able to do things a bit more at my own pace (with recorded lectures and whatnot) so I think having that throughout the term could be a benefit"*

Student Recommendations

Student recommendations fell into **three categories**: (a) keeping up with helpful online teaching techniques; (b) overcoming challenges; and (c) student support.

Students recommended the continued use of those **teaching techniques** that they found very helpful after the online transition in spring. These techniques included

- Recorded lectures. Recorded lectures were almost universally popular among the respondents as they found recorded lectures helped them review material, learn at their own pace and handle time zone issues. The majority of respondents preferred live lectures with a recording posted immediately after the lecture, but some respondents preferred a recording of the presentation posted prior to a live Q&A-type class session. Opinion was split on the value of live lecturing.

  In the meantime, students asked for better quality recordings. For this purpose, recommendations were: establishing quality guidelines, providing equipment (tablets, stylus and better microphones) to instructors when needed, producing quality recordings for the multiple sections of a course, close-captioning recorded presentations, posting videos of lab sessions, and using quality external resources (when needed) from a variety of sources.
- Question boards. Question boards were generally perceived as very helpful. Piazza's question functionality was preferred to Quercus' question functionality because of the ability to ask a question anonymously. Some respondents suggested that question boards be monitored and updated regularly so that students can receive answers in a timely manner.

Students also made the following recommendations on how to **overcome some of the challenges in online teaching and learning**.

- Increase student interactions in the online learning environment. A number of respondents asked that group work be increased but monitored actively by instructors so that they can have more interactions with their peers. While respondents also considered live lectures to be important to increasing interactions, they asked instructors to accommodate time zones.
- Adjust approaches to assessments. There was a consensus among respondents that take-home assignments or final projects would be a more accurate method to measure student learning, create less stress for students and make the process less prone to cheating. A number of

respondents asked that exams continue to have lower weighting in course assessment schemes. Other recommendations on assessments included using longer qualitative answers rather than multiple-choice questions, eliminating final exams, and testing for critical thinking rather than rote memorization.

- Enhance academic integrity in exams. Respondents believed that instructors making exams harder to discourage cheating did not work. They offered a variety of solutions to combat cheating on exams: using facecams, locking down students' personal computers while exams were being written, using invigilation software (e.g., Turnitin), mixing the ordering of questions, using software to create student-unique questions and/or input values, designing open-book exams, and avoiding multiple choice questions. Some students thought that pledges of academic integrity would be useful.
- Provide guidelines for both instructors and students on how to better teach and learn in the online environment. A number of respondents requested that guidance on how to learn and study effectively in an online environment be provided for students, acknowledging that an online learning environment was very different, and at times difficult. Respondents also asked that professors should not increase workload for students and be more approachable and supportive. Many students requested an increased number of TAs and increased office hours for both instructors and TAs, with multiple sessions accommodating different time zones, as another source of online learning support.
- Increase both consistency and flexibility in course delivery. Some student concerns suggested a need for greater consistency among instructors in the start time of classes—whether 10 minutes past the hour or not—and the break time between classes. Students also asked that consistency be enforced in online course design, assessment formats and weighting, software tools, and hardware requirements. In the meantime, students asked instructors to adjust course materials and teaching approaches for long lectures to maintain students' interest and engagement; and to better accommodate time zones by not making attendance mandatory.

In addition, students made recommendations on how to provide better **student support** in the online education environment.

- Enhance student services. Many students asked for access to counselling through online channels. Some students suggested that counselling services be made available without a reference from a doctor;[4] the availability of counselling services be better communicated to students; and more funding and resources be made available to expand student services, support mental health counselling and reduce wait times. Some students also asked for better communicating the availability of accommodation services and providing help to students who experienced technical difficulties or lacked private or quiet spaces, for example, by opening libraries and residences for students who needed the places to study and live.
- Improve the virtual environment. Respondents viewed a social, supportive, interactive virtual environment as a key to addressing social isolation. Group gaming and/or competitions, online clubs, virtual study groups, and virtual common rooms were all popular suggestions. Some respondents recommended that frosh activities be moved online in some way to allow first-year students to develop a sense of belonging to the UofT engineering community and build friendships with their peers. Students also expected that checkpoints would be put in place to ensure that students were participating in the virtual learning environment, both to increase

[4] This might be a communication or education issue.

motivation and have the appropriate interventions available if any students appeared to be withdrawing from the environment.

The following quotes help illustrate some of the points summarized above.

> *"Encourage professors to record live lectures and post them. If people miss class due to illness or mental health related reasons, or if they are distracted in their home environment, if their internet does not work well, etc.. it REALLY helps to be able to look back and completely understand a topic, especially because they might not be able to ask for notes from someone in class. "* (recorded lectures)

> *"Standardize what profs can and cannot do for delivery of lectures and assessments so that it is not the wild west again."* (increase consistency)

> *"exams should be turned into something like an assessment or a take home exam with long questions that require us to study. I think exams with increased difficulty and limited time are not help us learning at all since academic misconduct would really be formed."* (Adjust approaches to assessment)

> *"There are so many other and better options [than exams] - labs, take-home assignments, reports, presentations, design projects. In an engineering program, all of these evaluation methods can be used to display understanding, knowledge, creativity, etc. and most of them can be catered to an online-education situation much better than online exams can be."* (Adjust approaches to assessment)

> *"Implement invigilation software to ensure academic integrity for exams. Some of my peers may not like that, but it's for the greater good of humanity that we go out into the world as competent engineers."* (enhance academic integrity)

> *"Emphasize that the workload should not increase. The perception of having more work to do because you don't need to spend time commuting is detrimental. Perhaps make faculty seem more approachable, even more than they would have been in class."* (provide guidance for instructors)

> *"Definitely increase mental wellness resources and academic and transition resources for first years, as I'd imagine they would suffer the most with the transition, and would have the smallest social network at university to rely on."* (enhance student services)

> *"Implement scheduled, regular discipline common hours, discipline chats with professors and chairs, and faculty meetings, such as the 'Coffee with Chris' (I should have gone to one) virtually on BB Collaborate or zoom."* (Improve the virtual environment)

It should be noted that many students associated online education with lower quality and lower cost.

> *"Tuition should reflect this shift to online teaching. It would be an absolute nonsense to charge the students the same amount, as there will be no access to facilities and the same quality education (no labs for example)."*

Appendix: Data Collection, Characteristics of the Respondents, and Data Analysis Methods

Data Collection

The *FASE Undergraduate Student Survey on the Recent Transition to Online Learning* was administered via Microsoft Forms from May 11 to 25, 2020 to all undergraduate students who took courses during the Winter Term (January-April) 2020.[5] A total of 801 students responded to the survey, with a response rate of 22%, which is typical of student surveys within the Faculty.

The online survey included 28 questions that asked FASE undergraduate students about their perceptions of online teaching tools and techniques their instructors used after the transition to online instruction, challenges they encountered, experiences with final assessments, overall self-evaluation of their experiences, and mental health, in addition to a set of background and demographics questions. A total of 10 open-ended questions were asked; six of these questions received responses from over half of the respondents. The qualitative data provided highly rich information about student perceptions of their experiences with the transition to online learning.

The survey was designed and administered under the leadership of the Institute for Studies in Transdisciplinary Engineering Education and Research (ISTEP).

Characteristics of the Respondents

The characteristics of the respondents are shown below. Figures a-b and Tables a-b present their background information—year of study and program of study, as well as the courses they took and the time zones in which they were located during the winter term 2020. Tables c-e and Figures c-d present their socio-demographic information—race / ethnicity, gender, sexual orientation, residential status and Accessibility Services registration.

Figure a. Respondents by year of study

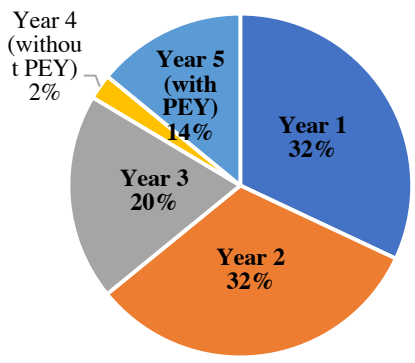
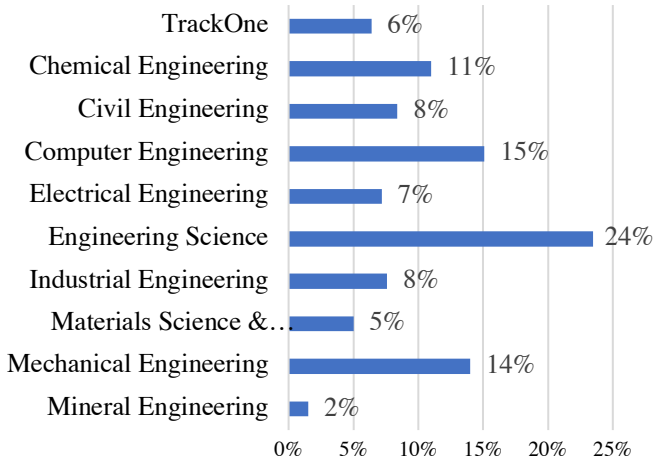


Figure b. Respondents by program of study



[5] The target population was 3,617 students.

Table a. Number of courses taken in the winter term, 2020

Courses taken	n	%
1-3 courses	21	3%
4 courses	77	10%
5 courses	381	48%
6 courses	305	38%
7-8 courses	17	2%
Total	801	100%

Table b. Time zones located for the majority between March 13 and April 30, 2020

Time zones relative to Toronto	n	%
+ 14 to 18 hours from Toronto (e.g., Australia)	1	0%
+ 10 to 13 hours from Toronto (e.g., China and Japan)	45	6%
+ 7 to 9 hours from Toronto (e.g., Middle East)	14	2%
+ 4 to 6 hours from Toronto (e.g., Europe)	4	1%
+ 1 to 3 hours from Toronto (e.g., Atlantic provinces)	8	1%
0 hours from Toronto (e.g., Ontario and Quebec)	676	85%
- 1 to 3 hours from Toronto (e.g., Western Canada)	52	7%
Total	800	100%

Table c. Respondents by race / ethnicity

Race / ethnicity	n	%
Black	14	2%
Central Asian (Kazakh, Afghan, Tajik, Uzbek, Caucasus, etc.)	2	0%
Chinese	197	31%
East Asian, excluding Chinese (Japanese, Korean, etc.)	40	6%
Latino /Latina / Latinx / Hispanic	19	3%
Middle Eastern	26	4%
South Asian (Indian, Pakistani, Sri Lankan, East Indian from Guyana, etc.)	105	16%
Southeast Asian (Cambodian, Filipino, Indonesian, Laotian, Vietnamese, Thai, etc.)	20	3%
West Asian (Iranian, Iraqi, Persian, etc.)	9	1%
White	155	24%
More than one racial/ethnic identity provided*	57	9%
Total	644	100%

*The race / ethnicity question asked respondents to check all that apply.

Figure c. Responsdents by Residential status

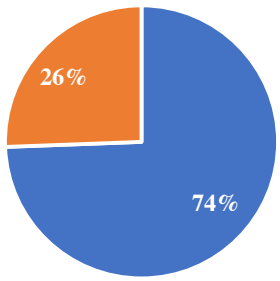


Figure d. Were you registered with Accessibility Services to receive academic accommodation in 2020?

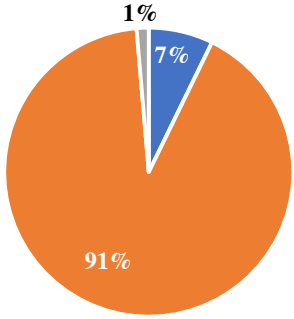


Table d. Respondents by gender

Gender	n	%
Gender fluid	1	0%
Man	327	48%
Non-binary	3	0%
Transman	1	0%
Two-spirited	2	0%
Woman	341	50%
Not sure/Questioning	3	0%
Total	678	100%

Table e. Respondents by sexual orientation

Sexual orientation	n	%
Asexual/Non-sexual	12	2%
Bisexual	45	7%
Gay	13	2%
Lesbian	4	1%
Pansexual	3	1%
Straight/Heterosexual	517	85%
Two-spirited	1	0%
Not sure/Questioning	14	2%
Total	609	100%

To determine how much the survey respondents represented the student population, comparisons were made between the respondents and the 2019-20 student enrolment with respect to year of study, program study, gender and residential status. Tables f-i suggest that lower-year students (Years 1 and 2), Engineering Science students, and women were over-represented in the sample.

Table f. Comparison between respondents and student population: By year of study

Year of Study	Respondents		Student enrolment in 2019-20	
	n	%	n	%
Year 1	255	32%	1260	28%
Year 2	256	32%	1107	24%
Year 3	155	19%	1050	23%
Years 4 and 5	131	16%	1146	25%
Total	797*	100%	4563	100%

*Two part-time students and one student in the 6th year are not included in this table.

Table g. Comparison between respondents and student population: By program of study

Program of Study	Respondents		Student enrolment in 2019-20	
	n	%	n	%
Track One	51	6%	239	5%
Chemical Engineering	88	11%	512	10%
Civil Engineering	67	8%	468	9%
Computer Engineering	121	15%	894	17%
Electrical Engineering	58	7%	549	10%
Engineering Science	188	24%	1010	19%
Industrial Engineering	61	8%	511	10%
Material Science & Engineering	40	5%	208	4%
Mechanical Engineering	112	14%	814	15%
Mineral Engineering	12	2%	75	1%
Total	798	100%	5280	100%

Table h. Comparison between respondents and student population: By gender

Gender	Respondents		Student enrolment in 2019-20	
	n	%	n	%
Men	327	49%	3252	62%
Women	341	51%	2003	38%
Total	668	100%	5255	100%

*Only men and women respondents are included in this table; respondents of other gender identities are not included in order to match the student enrolment data.

Table i. Comparison between respondents and student population: By year of study

Residential Status	Respondents		Student enrolment in 2019-20	
	n	%	n	%
Domestic Students	506	74%	3796	72%
International Students	174	26%	1484	28%
Total	680	100%	5280	100%

Data Analysis Methods

For the quantitative data, in addition to reporting the overall distribution of the whole sample for each survey question, we also used Kruskal-Wallis, Mann-Whitney or chi-square tests to detect whether statistically significant differences among student groups existed by

- year of study, excluding Year 4 (no PEY)
- program of study, excluding Mineral Engineering
- gender, only including men and women
- residential status (i.e., domestic and international students)
- race, only including Chinese, East Asian, South Asian, White and those who had more than one racial/ethnic identity
- sexual orientation, using the categories of straight and LGBTQ
- whether or not students registered with Accessibility Services

Those student groups were excluded from analysis due to their small sample sizes. Only those differences that were statistically significant have been reported in this document.

Occasionally, a Spearman's rho test or Pearson correlation test was performed to detect correlations. All the statistical analyses were conducted using SPSS or Python.

For the qualitative data (comments for open-ended questions), we conducted thematic analysis using NVivo or Excel to identify emerging themes and then triangulated the identified themes with the results from quantitative data.