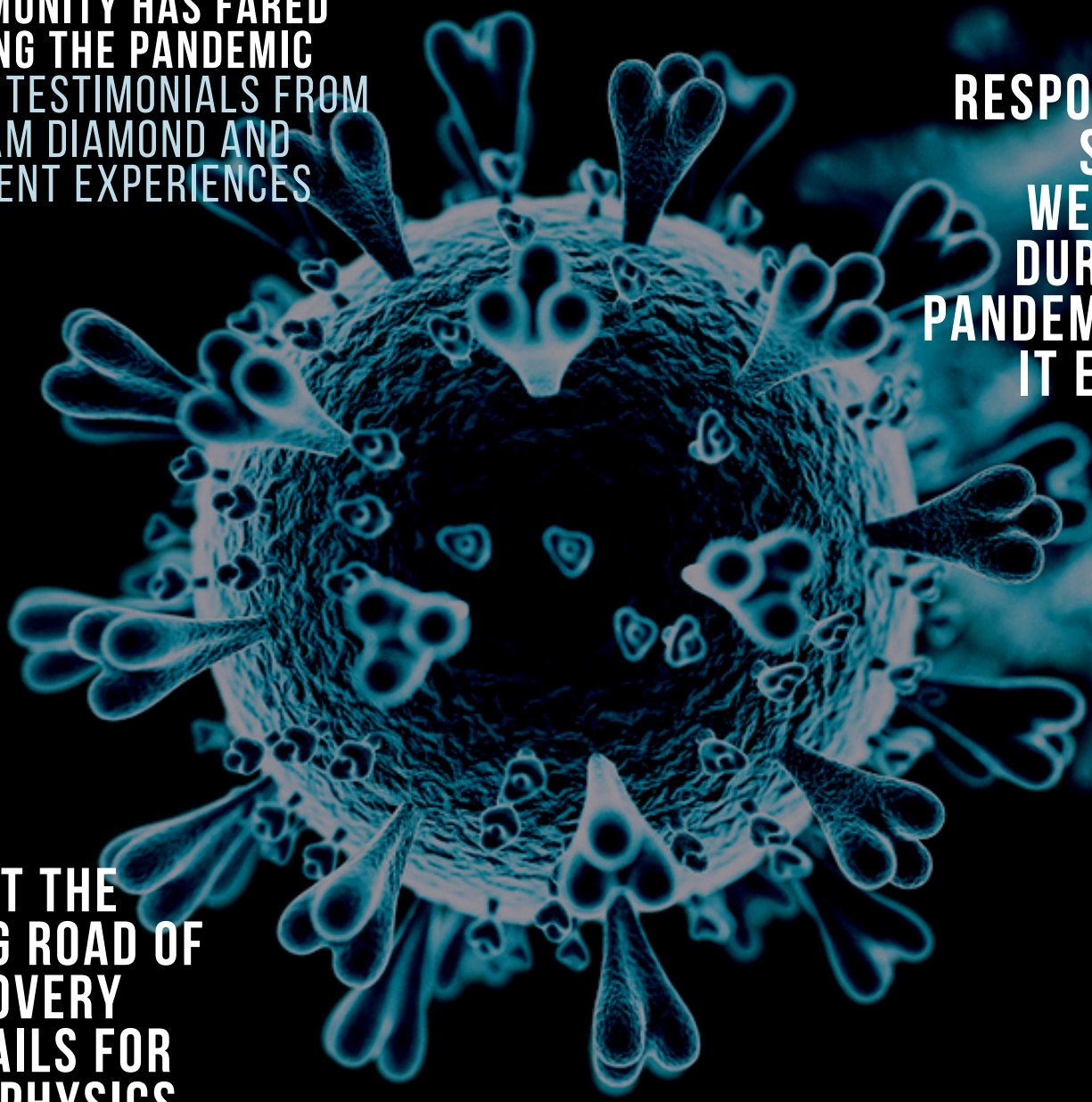
PHYSICS
IN THE TIME OF COVID-19

APRIL 2022

AN INSIDE LOOK INTO HOW UOFT'S PHYSICS COMMUNITY HAS FARED DURING THE PANDEMIC WITH TESTIMONIALS FROM MIRIAM DIAMOND AND STUDENT EXPERIENCES

UOFT'S RESPONSES TO STUDENT WELLBEING DURING THE PANDEMIC: WAS IT ENOUGH?



WHAT THE LONG ROAD OF RECOVERY ENTAILS FOR THE PHYSICS COMMUNITY

Submitted for JPH441 at the University of Toronto

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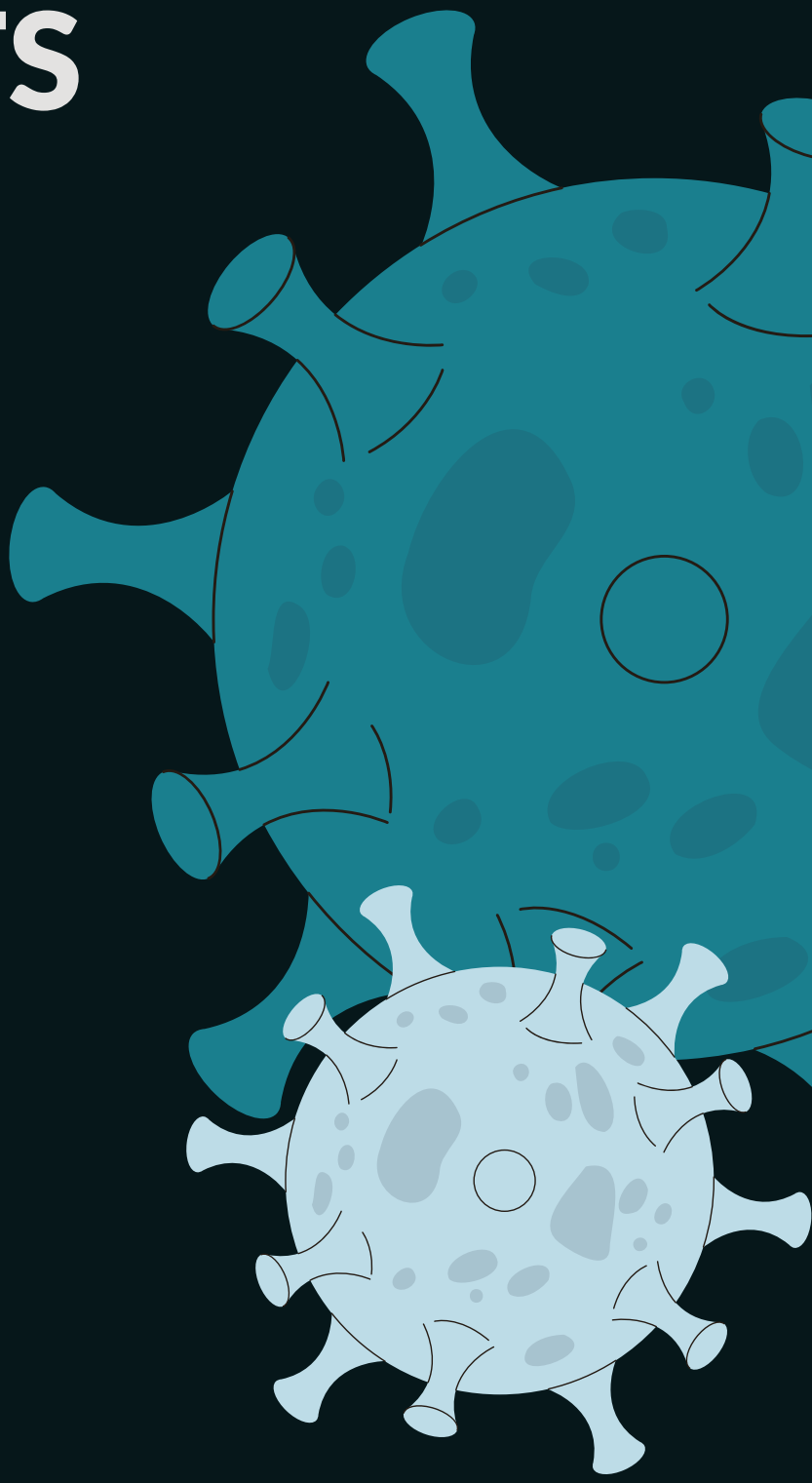


FOREWORD

Virtually every facet of life has been tested or changed over the last two years due to the COVID-19 pandemic. Since early 2020, our daily lives have been full of 'unprecedented circumstances' and 'novel challenges'. Initially intended for the University of Toronto's JPH441 ethics course pertaining to physics and contemporary society, this magazine aims to explore the positive and negative developments the physics community has undergone in response to the pandemic. Specifically, this magazine takes a sharper look at the University of Toronto's physics community through the use of a survey, while supplementing the findings with a plethora of academic articles from various physics communities around the world. While the survey was intended for all members of the U of T physics community, the majority of responses ended up being turned in by students. Furthermore, only 38% of responses were from individuals who identified as BIPOC, and 29% of the total responses identified as female. In the future, we hope similar surveys can be conducted over a more diverse data pool in order to achieve better informed results.

The main goals of this magazine are threefold. First, we aimed to critically analyze the impacts of the COVID-19 pandemic on the physics community at large. Second, we set out to evaluate the University of Toronto physics department's response to the pandemic. Finally, we hoped to develop strategies for mitigating these effects while also summarizing the benefits of the developments over the last two years. As the physics community is quite large, each of these goals were pursued through five different subtopics, pertaining to social impacts on the physics community, accessibility, education through the pandemic years, research and funding, and the applications of physics in COVID-19 research. Included in this magazine are a number of articles, testimonials, interviews and survey results which explore questions in each of these topics.

Initially conceived for use in the University of Toronto's own physics ethics course, we hope this magazine can stand on its own as a useful summary and source of information for members of any physics community. For students and instructors in North America, this magazine can serve as documentation of our shared experiences over the last two years, while for other physicists around the globe it can hopefully serve as a window into disposition on recent events. Either way, we appreciate those of you who take the time to read it, and look forward to further positive developments from the physics community.

-Janine Charoonruk, Mariam Elsayed, Alexandra Holgate, Jason Rock and John Elias Tzatzanis

Image: (Hooper)

SOCIAL IMPACTS

WRITTEN BY ALEX HOLGATE

Analyzing what the social impacts of COVID-19 are in the pandemic can be an endless discussion with a range of issues to dissect and surmise. While the world has been impacted by COVID, the types of which impacts and degree of them has been different for everybody. For the UofT physics community, students and faculty from a variety of backgrounds and fields have also had their share of unique experiences with the pandemic contrary to the average person. Keeping this in mind, when the research for this section began the big question that then stood out was, how do you decide what social impacts are more important than others when looking at members of the UofT physics community?

It is worth spending some time talking about how the categories for the social impacts were formulated for the purposes of this project. To start, preliminary research was done in order to get a sense of what other institutions were doing to measure how their communities were most affected by COVID-19. While few of the research papers pertained specifically to physics communities, we were still able to use studies done from other institutions as a guideline to our project. It was found that many of the papers had put together research surveys based on GoogleForms to gather data and information on behavioural changes as well as personal experiences. Their data pools consisted of roughly ~260-500 respondents for each peer-reviewed paper we looked at.

Overarching themes of mental health issues, eating disorders and isolation helped to formulate the categories for the social impacts section of our magazine that include: Mental & Physical Health, Discrimination & Xenophobia, as well as Physics Perception & Engagement with Physics Related News and Information. A GoogleForms survey was modelled after the papers that were reviewed to gather reflections from the UofT Physics community. Those results were then compared and contrasted with the social impacts that were initially researched from external sources. As well, UofT's response to these issues were taken into consideration. The following pages will now elaborate on the social impacts of the UofT physics community.

MENTAL & PHYSICAL HEALTH

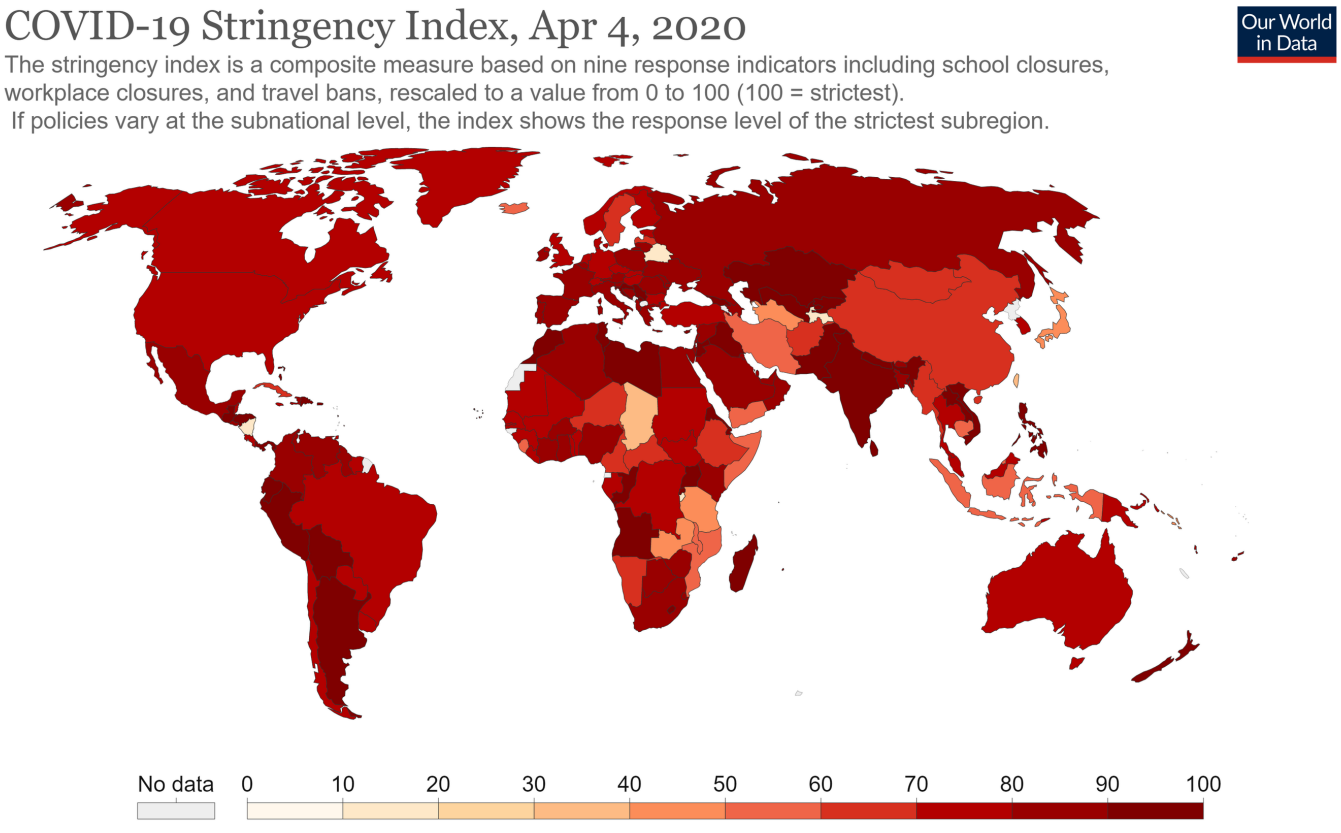
SOCIAL IMPACTS

With lockdowns implemented around the world a common side effect from being mandated to stay indoors for long periods of time was isolation for many as well as an overall decline in mental and physical wellbeing.

In David Cohen's book, Surviving Lockdown: Human Nature in Isolation, he discusses the positive impacts of being isolated. For individuals who seek out isolating themselves, creative and meditative values are listed as some of the pros, but Cohen raises the concern as to whom isolation benefits when it is not out of choice. He argues that involuntary isolation can end up causing more harm than good over long periods of time. But how long is too long for isolation to start affecting someone's health and in what situations other than a pandemic is involuntary isolation implemented? An unsavoury answer is: at correctional facilities that practice solitary confinement.

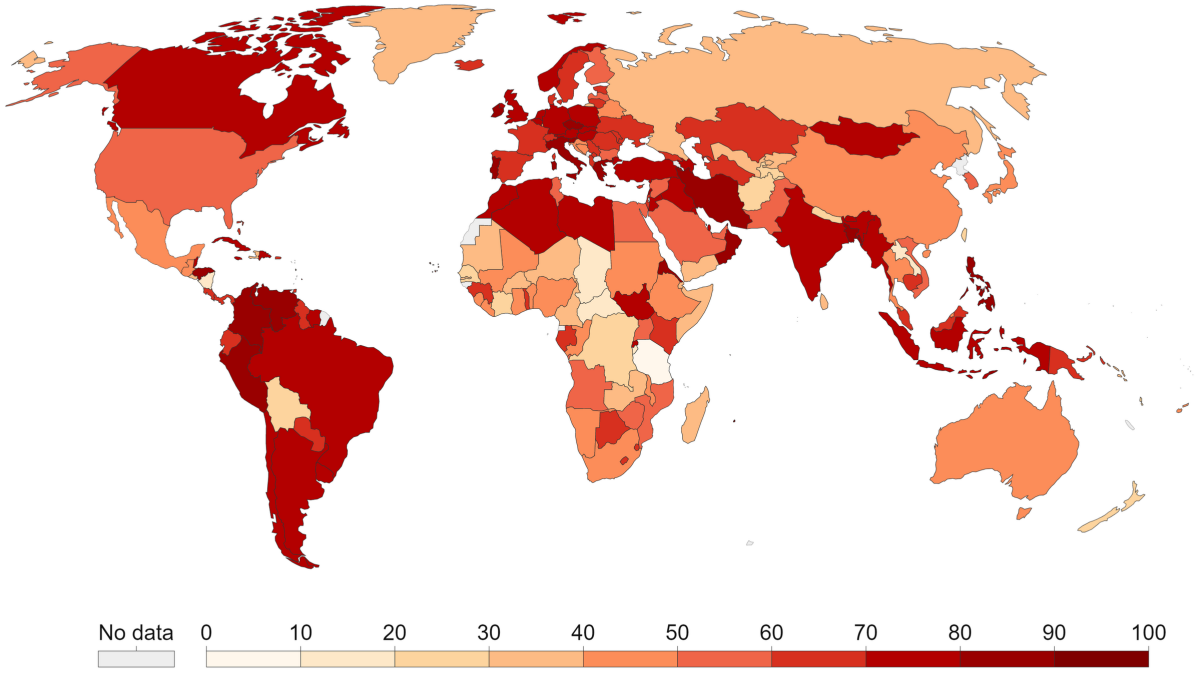
Research from the National Commission on Correctional Health Care in the United States argues that even just 15 days in isolation is cruel, inhumane and harms an individual's health (Cohen 25). A 14 day isolation period for quarantine is a common policy to mitigate the spread of COVID that unfortunately comes with harms similar, if not identical in more extreme cases, to solitary confinement. No doubt some of our readers have experienced isolation for this period or even longer due to quarantine policies.

When UofT physics students were surveyed about their mental and physical health it was found that 70% of respondents identified with feelings of isolation and negatively affected mental wellbeing. It is worth mentioning that all of the respondents were primarily living in Canada during the course of the pandemic, which notably had some



COVID-19 Stringency Index, Apr 4, 2021

The stringency index is a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100 = strictest).
If policies vary at the subnational level, the index shows the response level of the strictest subregion.



Source: Oxford COVID-19 Government Response Tracker, Blavatnik School of Government, University of Oxford – Last updated 17 April 2022, 13:50 (London time)
OurWorldInData.org/coronavirus • CC BY

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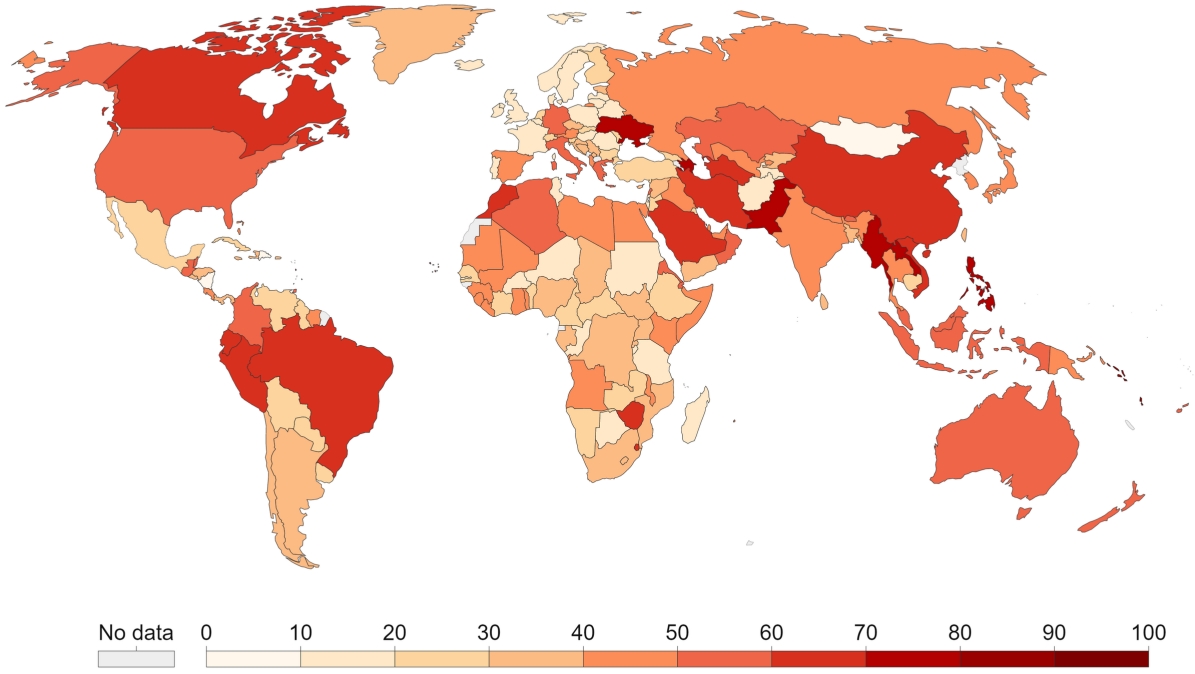


Source: Oxford COVID-19 Government Response Tracker, Blavatnik School of Government, University of Oxford – Last updated 17 April 2022, 13:50 (London time)
OurWorldInData.org/coronavirus • CC BY

of the longest ongoing and most stringent COVID response policies compared to other countries. Overall, Canada has maintained roughly an average value of 70 out of 100 on the Our World in Data Covid-19 Stringency Index (see Stringency Index figures) since 2020.

Policies that moved schooling online, restricted social interactions and shut down businesses had unsurprisingly detrimental effects on the health of students surveyed in the physics community. This percentage is comparable to statistics from studies done in the Philippines and India that also suffered from comparable stringency values.

In a study on loneliness and coping behaviours from the Central Philippines, 303 students participated and it was found that only 10% of the students identified as not being lonely over the course of COVID-19 (Labrague 1579). Moreover, close to 85% of 562 respondents from a research paper done in Assam, India identified as having negative and hopeless thoughts during the pandemic (George 202).

Similarly, when UofT physics students were asked about their physical health during COVID-19, 65% identified as having negatively affected physical health. When asked about whether their eating habits had changed during the pandemic, however, 53% did not feel their food habits had been altered. A guess as to why this was the case, despite feelings of declined mental and physical health, could be that students were already not eating well prior to the pandemic or had already established good eating habits that they could maintain.

All of this information so far may be unsurprising, but this next section of the UofT survey analysis is where we start to uncover nuances of the pandemic and its social impacts on the physics community. When students were asked whether or not they felt their chores and household responsibilities had increased during the pandemic only 35% identified with this being true. When we start to look at the breakdown of this percentage in social categories, however, all of the respondents who identified with this statement were women. So despite the overall percentage identifying with an increase in household duties being low, 5 out of 6 of the women surveyed felt this was strongly true for them.

Despite women identifying with a significant increase in household duties, the average answer for both women and men was 'neutral' when asked if they found school to be more academically challenging during COVID. However, logistically, women found studying online to be significantly harder than men. A possible correlation could be due to the increase in household tasks. Overall, these statistics share similarities with the more in depth research study done in India. That study also found one of the impacts of COVID-19 on women to be an increase in household chores and responsibilities. This resulted in women in Assam, India having a more difficult time engaging in academics compared to their male counterparts due to the overall lack of workspace at home for women who are expected to maintain gender roles.

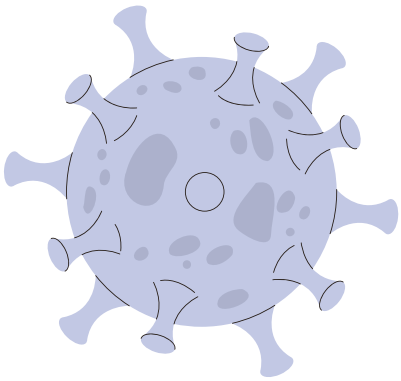
"A FEW WOMEN IN THE SAMPLE OPINED THAT IF THE LOCKDOWNS CONTINUE, WOMEN WILL BECOME SICK AND CRIPPLED BECAUSE OF THE OVERBURDENING CARE WORK AND DOMESTIC WORK AT HOME" (GEORGE 184-185).

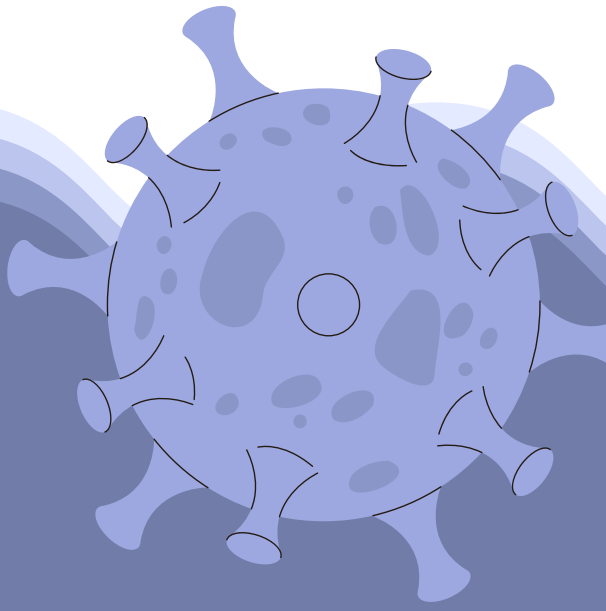
Because of the limitations of the questions asked on the UofT survey it is not clear what the increase in household chores and responsibilities looks like for female physics students other than the fact that the responses were nearly unanimous towards strongly identifying with an increase in home duties.

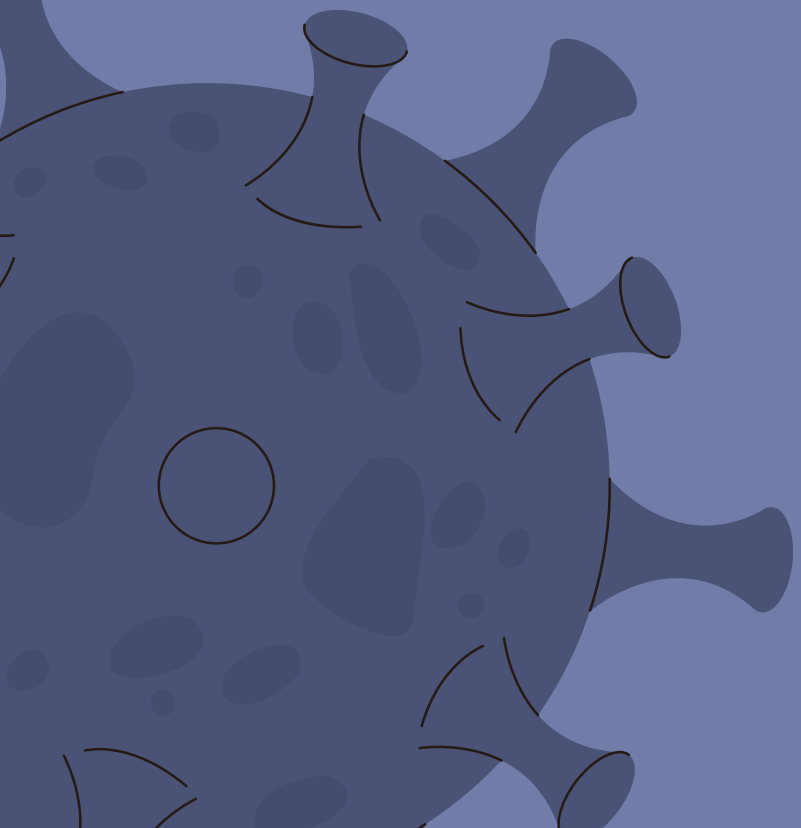
In total, the responses for mental and physical health were comparable between men and women. Both groups were generally negatively affected in these categories by COVID-19. Women's identifications with negative mental and physical health was only slightly increased overall compared to men. Unfortunately not enough data was gathered from non-binary physics students at UofT to be able to publish those results, but that is not

to say the queer community has not faced any unique hardships during the pandemic.

In conclusion, what these results tell us is that COVID-19 has affected men and women at UofT differently particularly when it comes to how women are more challenged to logistically engage in school. As discussed, possibilities of why this has occurred for women could be due to their increase in household duties or increased struggles with mental and physical health compared to their male counterparts.







WHAT IS U OF T DOING TO HELP STUDENTS THROUGH THE PANDEMIC WHEN IT COMES TO MENTAL AND PHYSICAL HEALTH?

During the pandemic UofT launched their COVID-19 resources website, UTogether, in an effort to consolidate information about the university's updates and efforts regarding COVID-19. Some of their resources for health and wellness include articles from both UofT experts and external sites. Namely, on the UTogether website a featured article is linked to a piece on Dr. Suze Berkhout's "Seven tips for staying grounded as the world grapples with COVID-19". This article provides tips as to how students can generally de-stress using grounding and meditative techniques. Overall, the main updates UofT has taken to address support during COVID-19 for its students has been done largely through the Health & Wellness Centre. On top of workshops and links to additional sources, in 2021 Health & Wellness added new services that included:

- SAME-DAY COUNSELLING FOR STUDENTS
- A FEEDBACK SUBMISSIONS SYSTEM AFTER EACH SAME-DAY COUNSELLING SESSION
- FOR STUDENTS WHO DON'T HAVE ACCESS TO PRIVATE/SAFE SPACES AT HOME, THE OPTION TO BOOK A PRIVATE ROOM WITH HEALTH AND WELLNESS TO DO THEIR SESSIONS

While these are significant improvements many still struggle with their mental and physical health during the pandemic. Moreover, students were asked to rate their awareness of UofT's COVID-19 policies and resources. While most students stated being aware of them, looking at the high responses for negatively affected mental and physical health indicates that there is still a gap between what the university is currently offering and what students are in need of in terms of support. Supplementary comments from the survey indicated UofT's resources were simply not enough.

The Health & Wellness Centre was contacted for an interview regarding their updated resources for COVID-19 and student support, but unfortunately we did not receive a response. Going forward, based on the results and clear complexities of social issues in UofT physics, it's possible that a solution to student support could be a more nuanced approach to what resources are available. While the university's support mandate is to provide specialized care to its students, the workshops typically available are more generalized approaches to student issues. Because we were unable to receive comments from Health & Wellness, it's unclear how specific social groups with more nuanced problems are getting tailored help during these times.

ACCORDING TO AN ARTICLE PUBLISHED BY THE HEALTH & WELLNESS CENTRE: "SINCE SEPTEMBER, THE HEALTH & WELLNESS CENTRE HAS PROVIDED BOOKINGS FOR NEARLY 3,000 SAME-DAY COUNSELLING SESSIONS, WITH 80 PER CENT BEING ONE-TIME-ONLY" (CLARKE)

Image: (Clarke)

XENOPHOBIA & DISCRIMINATION

SOCIAL IMPACTS

One of the horrifying impacts that COVID-19 had on the global community was the weaponization of the virus to justify hate crimes towards East Asians, in particular individuals of Chinese descent. In the peer-reviewed article, "Anti-Asian Hate Crime During the COVID-19 Pandemic: Exploring the Reproduction of Inequality", arguments for how Coronavirus became an enhancement for hate crimes is discussed. It begins with politics. Specifically, it began when Donald J. Trump, president of the United States at the start of the pandemic, labelled Coronavirus as the 'China-virus'. Other nicknames such as the 'Wuhan-virus' and 'kung flu' were also coined by other political representatives during this time (Gover 653-654). In the WHO's best practices for naming viruses, geographically affiliated names are explicitly off the table in order to prevent backlash towards certain social groups (Gover 653).

By creating an affiliation with the virus and East Asians it synonymously promoted anti-Asian stigmatization and hate crimes. Senator John Coryn stated in a press conference, "...that China was to "blame" for the spread of COVID-19 because they are a 'culture where people eat bats and snakes and dogs and things like that'" (Gover 654).

In the survey done at UofT, physics students were asked to rate their level of identification with having either experienced or witnessed an increase in acts of xenophobia and racism due to Coronavirus. Overall, 6% identified with having personally experienced an increase in xenophobia and discrimination due to COVID-19. Meanwhile, a sizeable 50% identified with having witnessed an increase in xenophobia and discrimination due to Coronavirus. It should be noted as well that the majority of respondents were white identifying and only 38% identified as BIPOC. Because there was not enough representation in any other category than Caucasian the results will be looked at as Caucasian vs. BIPOC overall.

When results were looked at through the separated perspectives of Caucasian vs. BIPOC the averages for having witnessed and experienced xenophobia and discrimination increase for BIPOC individuals. The instances where people strongly agreed with having experienced and witnessed these impacts were Asian respondents.

These results expectedly show a correlation between being a person of colour and therefore being witness to more racially charged hate and discrimination. It is unclear if any of these self-identified instances occurred on campus with other members of the physics community, but these numbers once again reflect varied experiences dependent on background.

In any case a number greater than zero is intolerable for having to experience any form of discrimination or bias. As well, even though it is unclear how much of these student experiences related to COVID and discrimination are happening on campus, UofT does have an extensive support page on their website called, "Anti-Asian Racism".

This page provides a series of links and resources that include how bystanders can respond to COVID-related racism. Another helpful link redirects to act2endracism.ca where incidents of COVID-19-related racism can be reported to help identify trends, perpetrators and assist in shaping future anti-racist policymaking. To conclude, the statistics on experienced racism and xenophobia were low in comparison to witnessed racism, but more work needs to be done to completely end these experiences. If we had to do this survey again, we would make sure to clarify if these incidents occurred on or off campus to determine if this problem is in any way related to the UofT physics community. This was one of the design flaws of the survey.

PHYSICS PERCEPTION & ENGAGEMENT WITH PHYSICS-RELATED NEWS/INFORMATION

SOCIAL IMPACTS

Another resulting impact of Coronavirus was the rise of conspiracy theories, anti-science rhetoric and misinformation. Michael Lynch poses the concern that, "instead of an outright rejection of science and objectivity, what is involved is an effort to produce adversarial claims of objectivity and institutional supports for those claims" (Prasad 89). His commentary pushes the notion that COVID-19 did not exclusively make way for anti-science modes of thought, rather, it enhanced how scientific fact and knowledge has been taken out of context and then reinterpretted to prove false claims. Coronavirus has been a nuclear catalyst to this sort of phenomenon spreading rapidly across various platforms.

When physics students at the University of Toronto were asked if their engagement with physics-related news and information had changed because of COVID-19, 53% answered yes. Supplementary comments to elaborate on this answer ranged from positive to negative realizations. On one hand, a few comments supported the importance of science communication and beliefs that it is a physicist's role to engage more in scientific conversations in order to help dispel misinformation as well as provide fact checking. One reflection considered the aid that physics provided during the pandemic, specifically, with modelling fluid dynamics and how COVID-19 droplets spread. On the other hand, one respondent observed that physicists 'amateur' attempts to model COVID-19 and health-related data reached too far beyond some physicists skill sets and could have contributed to misinformation. These were just a few key commentaries from the survey where, overall, a mixed range of answers reflected the benefits and drawbacks of physicist engagement with COVID-19.

Additionally, when asked if their perception on physics' role in society had changed due to Coronavirus, 62% answered no. So despite the increase in misinformation and conspiracy theories, physics students were largely unmoved in their opinions on the role of physics.

Overall, the results of this part of the survey were more difficult to interpret due to the likert scale formatting of the survey questions. As a result, the discussion here relied on the explanations people took time to write down in the comments section. As far as what role physics should look like during COVID-19, the comments largely spoke on the awareness of misinformed science circulating the news and generally leaned towards support for involvement in order to create better science communication and develop tools to aid in the study of the virus.

Beyond COVID-19, understanding how physicists should best be involved in science communication for future pandemics can help shut down misinformation before it spreads. This issue is one scientists in general will continue to face and needs solutions from improvements to science communication. As to how this is accomplished is up to scientists themselves to take on initiatives and seek out developing their science communication skills. One way to do this is through the university. By reaching out to department heads and requesting more educational resources for effective science communication, scientists can help bridge the gap between knowing science and knowing how to share that science with different communities.

PROFESSIONALS IN SCIENCE COMMUNICATION
PROFESSIONNELS DE LA COMMUNICATION SCIENTIFIQUE

MONDAY, MAY 9TH, 2022 at 5PM EST

Canadian Association of Physicists | Association canadienne des physiciens et physiciennes

Image: CAP

An opportunity we recommend signing up for is the Science Communication series being run by CAP. They will be hosting several part panels to focus on oral, written and visual communication skills for physicists. The panel will run from May 9th, 2022 to June 5th, 2022 and registration info can be found on the CAP website.

ACCESSIBILITY

WRITTEN BY JANINE CHAROONRUK

Zoe Budrikis wrote, in a short Nature article, about how the physics community spiralled into panic and worry in early 2020 as new regulations unfolded along with the development of the COVID-19 pandemic. More and more flights were cancelled as the situation quickly worsened, disrupting physicists' plans to travel to research conferences around the world. Researchers rushed to turn their attention into improving remote control capabilities of observatories. University lecturers had to make do with the current online delivery methods and make sure that students were receiving the same quality of instruction as they were getting in person (Burkidis 177).

While the novel coronavirus's transmissibility and lethality has shown us that it does not discriminate between demographics, there is also no doubt that the external consequences of the pandemic have been felt by every member of the physics community. But to what extent has the pandemic affected different people in academia? Or, to make the question more specific, how did different groups--differently abled people, neurodivergent people--fare in the wake of the pandemic?

From the survey that our group has conducted for the purpose of this project, it appears that many participants felt that they weren't being sufficiently accommodated by the University of Toronto during this tumultuous time, and that they were generally worse off during the pandemic. While such negative responses were expected given that the majority of the faculty's and students' routines/plans were effectively disrupted by the administrative changes implemented during this time, there are some voices in the survey (as well as in external literature) that express how some of these pandemic-based changes have been of great assistance to people who are disabled or neurodivergent. Such statements should be considered significant, given that over a third of the participants of our survey (38%) identify as neurodivergent or disabled persons, or are unsure of their status. This section of this magazine seeks to explore the extent of such changes made during the pandemic, in the lens of accessibility, and look at perceptions of U of T's COVID-19 response through the survey conducted by our group.

The most crucial and obvious change that has been brought upon at institutions everywhere during COVID-19 is the usage of online methods for hosting classes or doing work. A clear advantage to this is the lack of transportation needed in order to participate in daily activities. A considerable number of the participants of our survey identified themselves as commuters, and stated that tasks such as attending class/meetings or showing up to work through online methods freed up time that they would usually use to commute to campus. Such a method can also prove to be useful especially during the winter months, where the elements may hamper people commuting to U of T even more so. While it has its drawbacks regarding factors such as engagement or fulfilment, remote work/learning options are nevertheless valuable to mobility-impaired persons. Dr. Ashley Shew, assistant professor at Virginia Polytechnic Institute and author of a Nature article titled "Let COVID-19 Expand Awareness of Disability Tech", wrote about her experience in academia during the pandemic as a hard-of-hearing amputee. She states that her research group has already been "pandemic-proofed"--that is, her identity as a disabled person (who is only able to perform day-to-day operations in academia through special considerations and accommodations) has created several pathways for her to still be able to work effectively, even when factoring in the pandemic (Shew 9). She ultimately concludes that the COVID-19 pandemic serves as an example of institutions being able to quickly provide accessibility to a large group of people, and that an endeavor like this was long overdue for disabled persons; and if all academic departments were highly

accessible to begin with, chaos would have been minimized when COVID-19 hit (Shew 9). Dr. Shew's article serves as a case study that institutions like U of T should definitely consider when moving forward in a post-pandemic world. Student participants of our survey have also expressed their appreciation for the availability of recorded lectures and online notes--resources that were not available before the pandemic. Taking such factors into consideration, should we then be returning to our pre-pandemic ways? Or should some changes be made to the way students are able to learn in a normal school year?

It is important to note that the pandemic measures implemented in academia, such as online learning/working, are not without their faults either. About 54% of the disabled/neurodivergent participants of our survey still stated that they didn't feel that physics became more accessible to them during the pandemic. Additionally, other new barriers may have arisen with online methods: for instance, the quality of the internet connection at students' or instructors' homes may not be stable; alternatively, some people may be living in environments that are not very conducive to studying or working. How can these issues be tackled, then, to pave the path for an even more accessible remote learning/working environment? Jonathan Lazar explores adjacent issues that have arisen in various academic institutions during the pandemic in his paper by looking at differently-sized universities and investigates what kinds of problems they have each encountered during this time. The case study explored by Lazar that closely resembles that of U of T's the most is the "large-sized university" category as established in the paper. The issues that this university encountered during COVID-19 included a lack of channels for reporting accessibility complaints on school technology (Lazar 10), and an increased demand for video captioning (Lazar 11), which was complicated by a lack of centralized funding for such efforts (Lazar 10). Additionally, online courses were also not required to be immediately accessible--unless a student who is registered with accessibility services was enrolled in the course (Lazar 10). PDF accessibility also became an issue for universities of all sizes as discussed in the paper, which could be traced to the increased dependence on digital documents being used more often during the pandemic instead of physical/paper ones (Lazar 16). On the bright side, though, this

Image: Associated Press

university did provide accessibility training courses--which saw a sharp increase in participants during the Fall 2020 semester. There were also grants given to instructors who were willing to make adjustments to their curricula in order to make them more accessible to students (Lazar 11). Towards the end of the paper, Lazar lays out specific perspectives and steps to take in order to increase and maintain digital accessibility during and after the pandemic. Some such examples are:

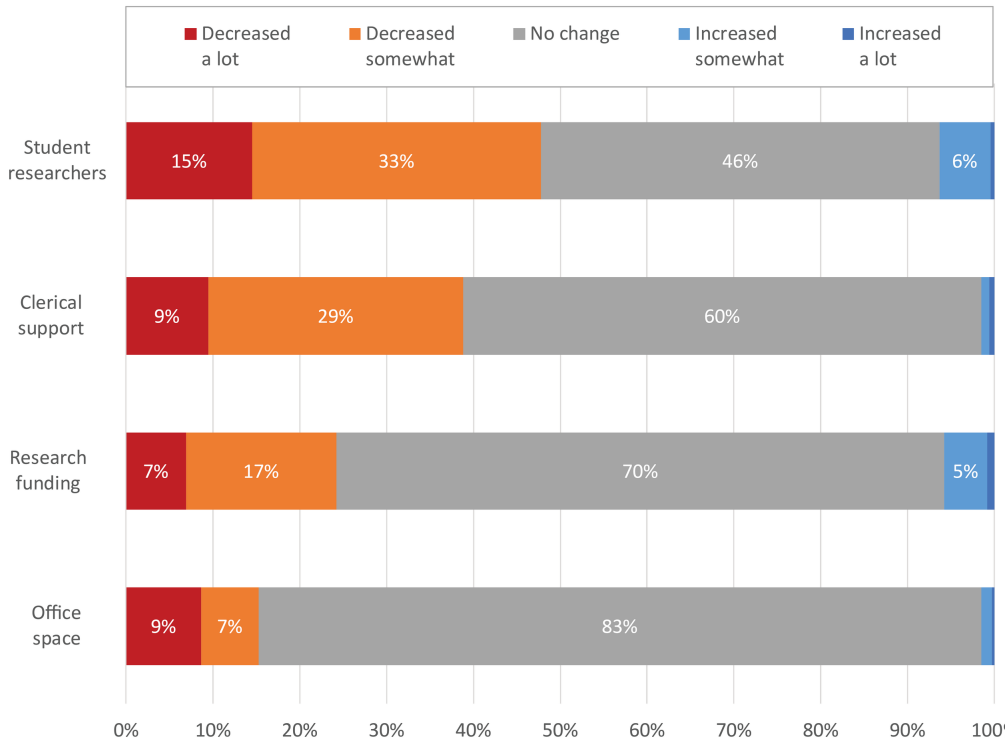
1. "FIND WAYS TO ENSURE THAT ACCESSIBILITY REQUIREMENTS REMAIN IN PROCUREMENT DURING EMERGENCY SITUATIONS;
2. LIMIT "EMERGENCY PROCUREMENT AUTHORITY" WHICH BYPASSES ACCESSIBILITY REQUIREMENTS, AND ELIMINATE IT AS SOON AS IT IS FEASIBLE
3. PROVIDE AS MUCH ONLINE TRAINING AS POSSIBLE RELATED TO DIGITAL ACCESSIBILITY, AND PLAN FOR INCREASED ENROLLMENT DURING THE SEMESTER BREAKS (SUMMER AND WINTER)" (LAZAR 16).

As a whole, the author believes that it would certainly be a good idea for U of T to look at how other large institutions are faring during the pandemic and learn more about what things to do or avoid doing in order to increase accessibility in academia.

In terms of physics research, the American Institute of Physics (AIP) has released a report on how access to resources have changed for researchers during the pandemic. Their research is aptly summarized through the graphic below.

Here, it is clear that a significant portion of researchers have experienced some decreases in regards to student researcher and clerical support. This is likely attributed to the heavy dependence on working from home during the pandemic, which can make such support systems harder to access or utilize--especially if they are needed to assist in physical or experimental matters. However, there also exists a small portion of people who have experienced an

Changes in Access to Resources During the COVID-19 Pandemic for Physics and Astronomy Faculty Members, Spring 2021



Note: Proportions are based on the number of active physics and astronomy faculty members who responded to each item and did not select the "Not applicable" response option. Unlabeled percentages each represent < 5% of the respondents. Three additional figures included in the appendix present changes in access to resources by the highest degree granted by the department.

AIP | Statistics

aip.org/statistics

Image: (Walsh and Tyler)

Image: (Misirligul), Shutterstock.com

increase in student researcher support (marked in blue); this may be referring to those who are in more theoretical streams of physics, where online methods may have been able to facilitate better communication channels/efforts between researchers and student researchers. However, as a whole, it appears that the majority of physicists who have participated in this study did not experience significant changes in the way they are able to access different resources during the pandemic.

From our research and the perceptions of authors in the related literature, it becomes clear that accessibility during regular academic years is already limited. It is ironic, even, that there currently exist more courses about accessibility that are available in different universities now more than ever--yet the actual functional accessibility in these institutions still leave much to be desired (Putnam 13:16). However, the research we have done shows that the COVID-19 pandemic can serve as an opportunity for us to re-evaluate our current work/school norms and solve existing accessibility issues through the "lessons" we have learned in the past two years.

U OF T'S RESPONSE TO ACCESSIBILITY CONCERNS DURING COVID-19

The University of Toronto has released an online guidebook that specifically targets the transition period (i.e., moving from the nearly-two years of studying/working online, and back to an in-person setting) for disabled persons. It contains information such as links to specific resources regarding a problem or situation that U of T students and faculty may encounter, as well as guidelines/do's and don'ts to keep in mind during this time (University of Toronto).

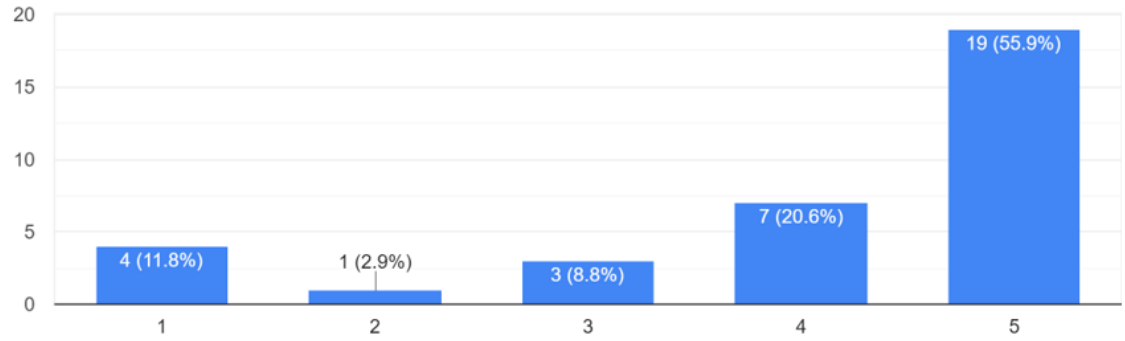
You can access this document through the link https://people.utoronto.ca/wp-content/uploads/2020/09/Returning-to-Campus-during-COVID-19-Keeping-Accessibility-in-Mind.pdf, or through scanning this QR code:

SURVEY RESPONSES

LEGEND: 1) STRONGLY DISAGREE, 2) SOMEWHAT DISAGREE, 3) NEUTRAL, 4) SOMEWHAT AGREE, 5) STRONGLY AGREE

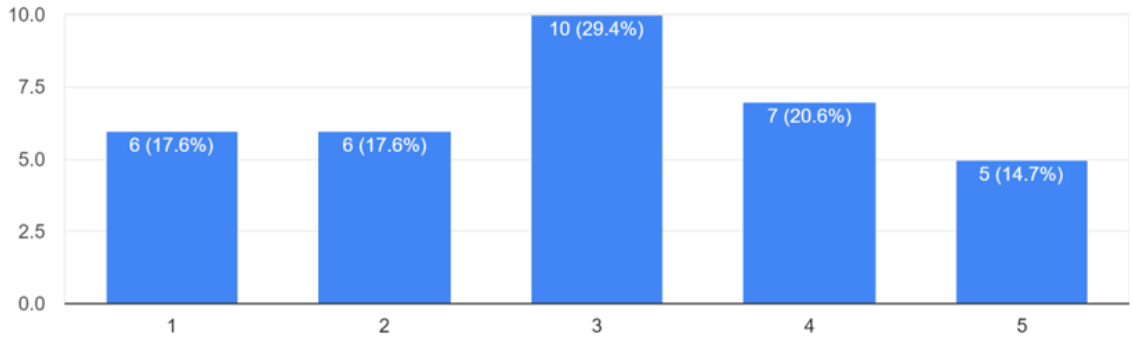
"I believe that online learning options and other educational resources (such as lecture recordings or notes) should still be continued/made available after the pandemic is over."

34 responses



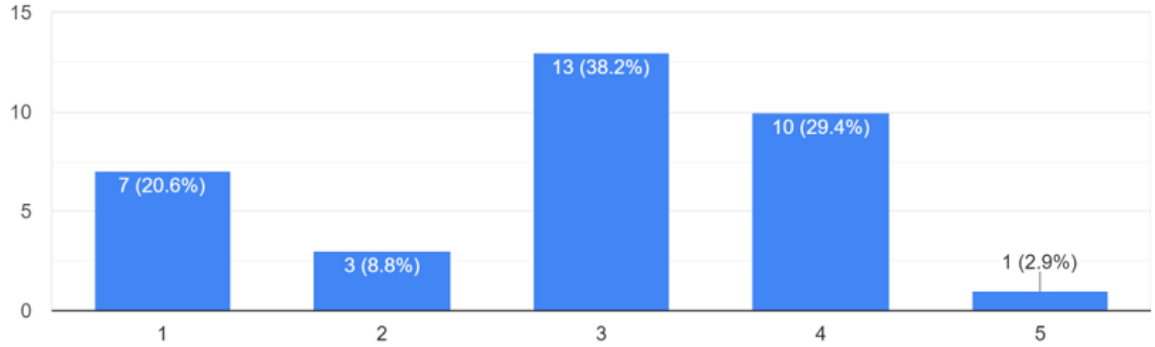
"COVID-19 has made physics teaching/learning and physics resources more accessible for me than it was before the pandemic."

34 responses



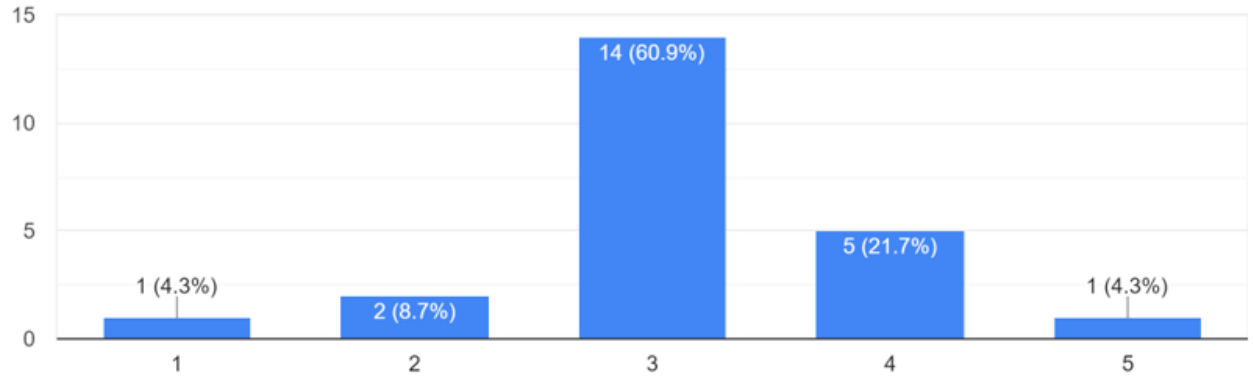
"U of T has done a good job in accommodating faculty and students during the pandemic." [Skip if you are not a teacher or student]

34 responses



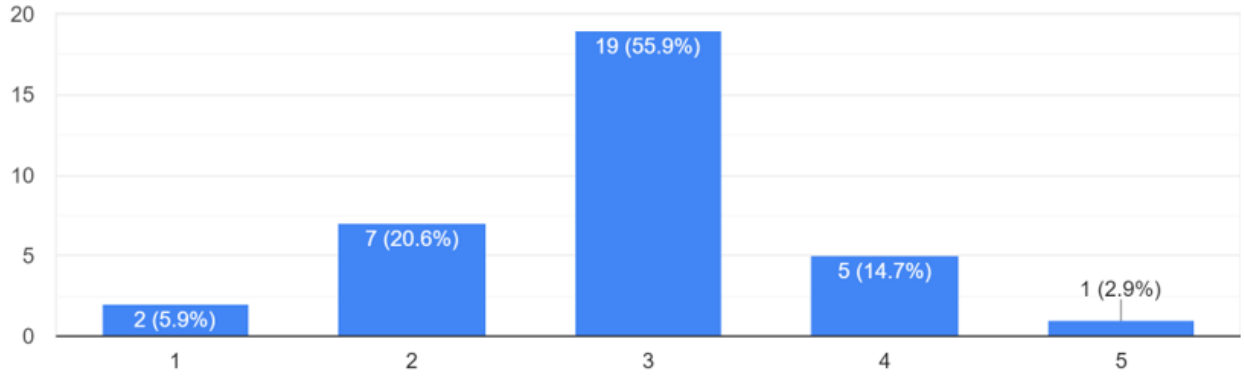
"UofT has done a good job in accommodating researchers during the pandemic." [Skip this question if you are not a researcher]

23 responses



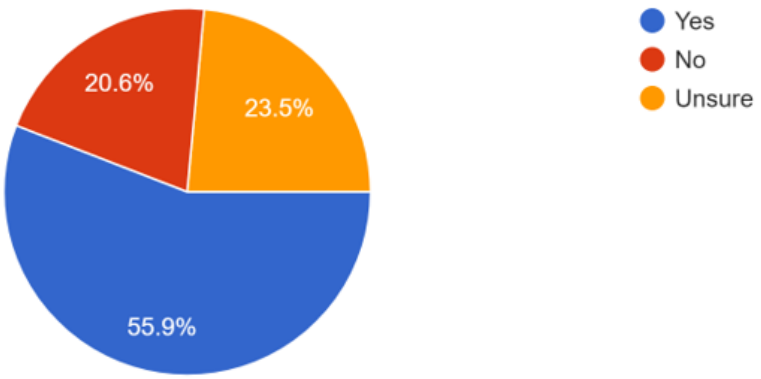
"UofT has provided a good amount of accessibility-related resources and/or policies in the face of COVID-19."

34 responses



Are you familiar with UofT's accessibility resources/policies for COVID-19?

34 responses



A CLOSER LOOK...

AT HOW COVID-19 HAS MADE PARTICIPANTS' LIVES MORE/LESS ACCESSIBLE:

"Online conferences have certainly made presenting my work at a larger number of meetings more accessible, but the other valuable aspects of attending a conference (eg. networking, finding opportunities for collaboration, etc.) have been almost totally lost. In some ways this reduces the accessibility of physics long-term, since it could mean lost job or postdoc opportunities."

"As a commuter student, I would have to wake up extremely early to come to school for a 9 or 10 am class. I was very tired and this truly made it difficult to focus during class. Having online classes allowed me to wake up at a later time and having the lecture recording allowed me to revisit the material at a later time if needed. Similarly, being at home allowed me to be in a space where I felt comfortable and without distraction."

"I have seen many post-doc positions start to offer a hybrid start to the employment period. I believe this has made those jobs more accessible as it allows people to start working virtually while waiting for their thesis to get processed or visas to be accepted."

AT WHETHER U OF T HAS DONE ENOUGH DURING COVID-19, IN TERMS OF ACCESSIBILITY:

"I am mostly neutral on this subject. Like all of us, the administration has had to work with limited and fast-changing information, so while they could have done better, they also could have done a lot worse. I will say they were generally reactive instead of proactive in their decisions, and often needed public pressure to end up doing the right thing (eg. initially they planned on using the honour system with regard to vaccine requirements, but then later changed their mind and required proof to be uploaded to Ucheck)."

"I understand the university is still a business but did I really have to pay the same amount of tuition money given that the quality of learning online may or not have been the same as in-person - and again, the whole world is ending is school really the most important thing in my life rn narrative (more mental health services or anything really that could have addressed this)."

"I think that overall U of T has been more concerned about profit than student/faculty health as the pandemic drew on. Not because of any statements of press releases that were given, but because of the policies that were made and actions that were taken."

AN INTERVIEW

ON ACCESSIBILITY DURING COVID-19

When our survey was first shared to the U of T Physics Student Union Discord channel, a few people expressed their immediate interest in completing it, stating that they did feel that U of T has not done well in handling the effects of the COVID-19 pandemic. One of these people was Yiğit Özçelik, a 4th year student who is currently pursuing a Physics and Astronomy specialist program. He thinks that UofT's pandemic handling has been quite a mess. I have decided to reach out to him for more comments, and asked him how the pandemic has been for him as a neurodivergent student at U of T.

Janine: How accommodating has U of T and/or the physics department been to you pre-pandemic, as a neurodivergent physics student? What kinds of accommodations were made for you?

Yiğit: I was not aware that I was neurodivergent pre-pandemic. However, I was registered with Accessibility Services for depression, and I can say that while I met great and considerate people through the support networks offered to me, by and large the accessibility accommodation process is bureaucratic, opaque, tiring and stressful.

Janine: How do you perceive U of T's overall sense of pre-pandemic accessibility from your point of view?

Yiğit: I think it is half-hearted. The school focuses more on producing a small cadre of prestigious physics graduates than on ensuring every student is able to learn physics.

Janine: What kinds of changes did you personally face when the pandemic first struck (lifestyle, school, health, etc.)?

Yiğit: I was trying to study without almost any of my peer network, from eight (sometimes seven) hours away (timezone wise), during a universally traumatic time, under UofT's usual heavy and unsustainable workloads and expectations. I have never been in a worse state of mental health than how I was at the end of my only fully online pandemic semester (Fall 2020).

"THE SCHOOL FOCUSES MORE ON PRODUCING A SMALL CADRE OF PRESTIGIOUS PHYSICS GRADUATES THAN ON ENSURING EVERY STUDENT IS ABLE TO LEARN PHYSICS."

Janine: How has U of T accommodated you during the bulk of COVID-19? Do you feel like these measures were enough, or were there any specific instances where you felt like you were still struggling despite these pandemic accommodations?

Yiğit: I feel like UofT left me hanging. Some professors were unaware of, or indifferent about, timezone challenges; others made very little effort to interact with students. The process of obtaining and maintaining accommodations from a foreign country was more burdensome, complicated and stressful than ever.

Janine: As we continue to move towards a sense of normalcy at U of T, do you think there are some accessibility-related things that could have been handled differently by the university and/or the physics department during the first two years of the pandemic?

Yiğit: There are many structural issues with accessibility at UofT, but the chief thing that comes to mind about the pandemic period is accommodating international students. I felt like an afterthought, and I know people who had it worse.

Janine: Is there anything you'd like U of T to consider or implement after COVID-19 is over, in terms of accessibility?

Yiğit: Implement and maintain a database of online lectures and ancillary course materials for every course, in order to assist students who have trouble making it to class (due to mental health, logistics or whatever else) catch up to their peers. Lecture recordings have been an unexpected boon, but I think they can be vastly improved.

PHYSICS EDUCATION DURING THE PANDEMIC

WRITTEN BY JOHN ELIAS TZATZANIS

Image: theconversation.com

LEARNING PHYSICS IN A NEW WORLD

No matter the circumstances, post-secondary studies in physics are often challenging, yet rewarding. Beyond the usual stress factors of exams and problem sets, however, the past two years have tested the adaptability of institutions at large and the greater physics community. Due to the coronavirus pandemic, most university physics programs were forced to shift to some capacity of online instruction (Sahu), raising a host of new challenges. The traditional approach of teaching physics through lectures and hands-on labs was simply not possible at certain points, warranting a reimagination of physics education. While the pandemic had ramifications on all aspects of student life, some key concerns related to the technology needed for the delivery of course material, the new ways in which students could be fairly evaluated and the financial ramifications on the institutions and students alike. A variety of strategies were tested in order to navigate these difficulties, and while some were found to be less effective than others, certain innovations such as recorded lectures and asynchronous resources may remain in place well beyond a return to normal life.

TECHNOLOGY

The first challenge which reared its head when universities began to close involved the implementation of technology needed for successful online learning. While some professors and students may have had a degree of familiarity from optional online courses in the past, the vast majority were entering into unknown territory (Sahu). Beyond the accessibility issues of accommodating students who did not have access to laptops or stable internet

connections outside of school, there were also a variety of delivery options which were competing for approval. Some professors opted to record all of the material beforehand, creating an entirely asynchronous course where the students were free to access the material whenever they pleased. Other professors opted to maintain the scheduled hours of their class and livestream the content from their own home, while a third group implemented a mix of both strategies. Not only were delivery methods inconsistent though, but a plethora of platforms such as Zoom, Bb Collaborate, Canvas, Piazza and YouTube were all combined to add further complexity to the situation. With each instructor selecting their own method of delivery, staying on top of the quirks of each system was an added challenge to the endeavour of studying physics online.

ASSESSMENT AND EVALUATION: EXAMS

Beyond sorting out the logistics of how the material should be delivered, the mass shift to online learning also raised questions as to how said material could be properly conveyed and evaluated (Sahu). Standard practice in the physics community was to have exams and problem sets to test the knowledge retained from lectures. In many cases, however, formal exams were outright cancelled near the beginning of the pandemic, for fear of loss of academic integrity, as students taking exams online in many cases have unmonitored use of the internet (Watson and Sottile). In order to curb academic dishonesty, some instructors employed lockdown browser tabs (Kuppers 192), which limit the functions a student can access while writing a test. Issues surrounding the usability and security of this technology began to surface, as occasional incompatibilities between the lockdown software and the testing softwares and proved this to be an ineffective solution (Kuppers 193). An alternative approach which was taken in some cases was to shift the focus of physics exams away from the memorization of formulas in favour of general conceptual understanding, thus diminishing the advantage posed by having the internet readily available. Take-home exams, which resembled the already existing problem set structure common to physics courses, took for granted that students had access to resources such as the internet or their notes to confirm the accuracy of formulas or to help compute integrals and derivatives, but instead tested them on their ability to recognize when such computations were necessary and how to they were to be interpreted. Overall, this shift in testing could be argued to be more representative of real life as a physicist, as it is very rare for researchers to not have access to such resources while they are conducting their work.

ASSESSMENT AND EVALUATION: LABS

A secondary source of evaluation in physics education comes from the reports submitted in response to hands-on lab experiences. Since face to face lab time was restricted throughout the pandemic, a variety of strategies were needed to maintain a similar degree of learning. Some lab courses were forced to remain fully online, meaning that experiments and demonstrations which required specific equipment needed to be live streamed or prerecorded, similar to lectures, for students to follow along at home (Ametepe and Khan). In other cases, new experiments were devised, such as the analysis of a simple pendulum, which could be constructed and investigated at home with common materials available to students (University of Toronto Physics Department). Lab courses which were lucky enough to accommodate in-person learning still needed to adapt to capacity restrictions depending on the region, and so in many cases students were asked either to conduct their experiments on alternating days, or experiments which normally required partners or teams were modified to be completed solo (Ametepe and Khan). Despite the challenges associated with these new learning strategies, it was found that the average grade in online courses throughout the pandemic were marginally higher than previous traditional years, despite also having a higher rate of withdrawal (Ametepe and Khan). Furthermore, it was noted that students who attended mostly synchronous activities tended to have more success than those who mainly attended asynchronous activities (Guo). It can be concluded then that while these strategies tended to be successful for students who were capable of taking on greater responsibility for their own education, many students who struggled to keep pace were allowed to slip through the cracks.

DISTANCE LEARNING

A positive impact which has followed the mass adoption of online learning in the physics community is an increase in distance learning. Distance education occurs when students are engaging in a program which is physically distanced from their place of residence (O'Brien). During most traditional years, in-person activities have been crucial for physics education, preventing the practice of distance learning. As a result, advanced studies in physics have been less accessible to those living in regions farther from the institutions at which they aim to study. International students typically have had to take on greater financial and logistical challenges in order to pursue their education in physics. Despite the initial financial and logistical challenges posed to international students who were abruptly forced to return home at the start of the pandemic (Sahu), online learning has allowed them to continue their education from afar. Moving forward, if certain strategies developed during the pandemic such as synchronous online learning are held in place as options for such programs, post-secondary physics education can become more accessible to students across the globe, expanding the reach and scope of the physics community.

FINANCIAL IMPACTS

On top of the technological and pedagogical challenges faced by the physics education system throughout the pandemic, institutions also faced financial problems of their own. Chief amongst the students' concerns related to unchanged tuition fees. Many students felt that the quality of education which they were receiving online was not comparable to that received in previous, more traditional years, and felt that tuition changes should be implemented to reflect that. Universities themselves, however, have been facing losses of their own due to housing refunds, event closures and other unexpected expenses, with many American universities such as the University of Michigan experiencing hundreds of millions of dollars in net losses (Friga 2). Canadian universities have felt the financial strain of the pandemic as well, as evidenced by the cutting of 58 undergraduate and 11 graduate programs at Laurentian University in order to avoid bankruptcy (Greenfield). While the fiscal struggles of Laurentian University date back well beyond the beginning of the pandemic, the recent crisis can be seen as having been the straw that broke the camel's back. Similarly, the precarious financial situation of Ontario Tech University was further strained by the pandemic and led to the looming threat of staff strikes throughout the 2021-2022 school year (Brown and Manucdoc). Not only have the last two years been challenging in the classrooms, but also in the administration offices for physics institutions.

MOVING FORWARD

Despite the obvious strains on the education system at large over the last two years of the pandemic, there is hope for the physics community that it can grow in the future using strategies developed as a response to online learning. Strategies such as recorded lectures,

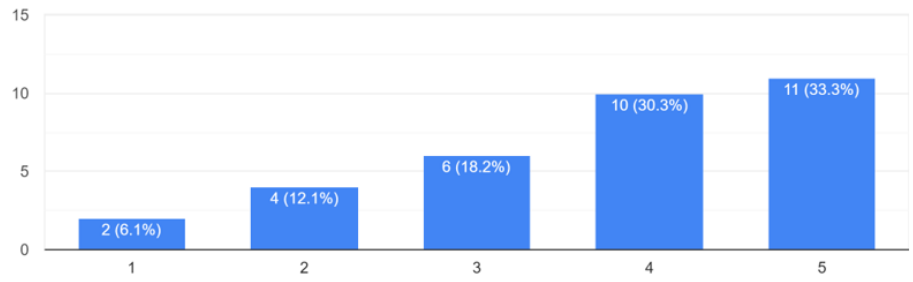
Image: michiganvirtual.org

whether they are delivered synchronously or asynchronously can help supplement in-person learning in the future by providing students with another resource to engage with the material. Furthermore, the increased presence of an online physics community through platforms such as Piazza can further bring science-minded people together and strengthen both formal and informal avenues of communication between instructors and students, supporting conversations over broader physical distances. While there are bound to be certain lasting consequences, such as exacerbated financial concerns due to the pandemic, an overall shift in attitude towards prioritizing conceptual understanding over rote learning can help to strengthen the physics community well beyond a return to normal. Many may have missed traditional physics education experiences over the last two years, however very few will be keen on abandoning all of the new strategies adopted once a full return to normal is possible. Afterall, the science community is best known for its ability to self-correct, and this trait is evidenced once more in its reimagination of the physics education system.

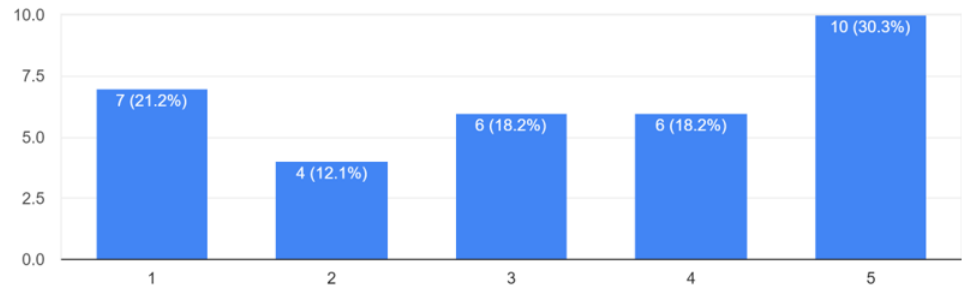
SURVEY RESULTS

Legend: 1) Strongly Disagree, 2) Somewhat Disagree, 3) Neutral, 4) Somewhat Agree, 5) Strongly Agree

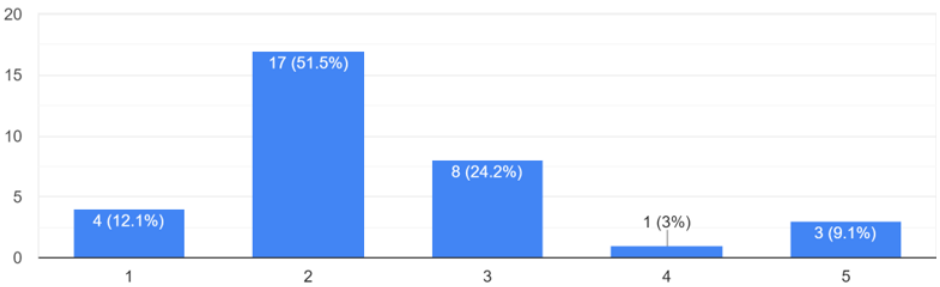
"Academically, studying physics mainly online throughout the pandemic has been more challenging than traditional years." [Skip if you are not a teacher or student.]
33 responses



"Logistically (with regards to work/family/class balance), studying physics online throughout the pandemic has been more challenging than traditional years." [Skip if you are not a teacher or student.]
33 responses



"Overall, the strategies implemented in online physics education were successful and created a learning environment which was comparable to tradit...ears." [Skip if you are not a teacher or student.]
33 responses



TESTIMONIALS FROM ANONYMOUS MEMBERS OF U OF T PHYSICS COMMUNITY:

BIGGEST CHALLENGES:

"A big challenge for me has been the inconsistency in delivery modes. Having classes switch back and forth between online and in-person during the same semester, or having to take some classes online while taking others in-person at the same time, has made it near impossible to maintain effective study habits. I imagine other students in physics (and other disciplines) can relate."

"I found it very difficult to gauge whether students were understanding my explanations while teaching. Almost none of my students would turn on their camera during virtual lessons and not having the visual feedback of their body language and facial expressions made it hard to guess whether my explanations were helping. I believe this would be a common experience to all those who teach online."

"Instructors have had obvious difficulties adjusting to remote formats for traditionally synchronous activities like exams and practicals, and since many had to be remade from scratch for a remote setting, many flaws that would normally have been ironed out over the years appeared anew."

CLEAREST ADVANTAGES:

"Having lectures recorded to rewatch. Several of my peers feel the same way and have asked professors to record in person classes as well, since it is very helpful to be able to rewatch lectures later to review parts you didn't understand."

"Accessibility. I appreciated having the opportunity to revisit lecture material at a later time. Rather than having to worry about copying all material on the chalkboard, I would place all my attention on understanding what the professor was trying to explain."

"Open book tests - not as much memorization, more understanding."

"I believe the biggest advantage of online learning was that students could continue their courses while not physically near campus. I know this allowed many students to spend more time with their families and/or save money on living expenses. I believe this would be common to all online learning situations."

U OF T'S RESPONSE

Over the last two academic years interrupted by the pandemic, the University of Toronto has implemented a variety of measures to cope with the challenges to physics education outlined in the previous article. In order to address issues with access to technology, for example, the university has posted minimum technical requirements, such as storage and RAM memory space needed in order to accommodate online learning platforms, and has made emergency bursaries available to those who need assistance in meeting these requirements. They have even made the university's general Virtual Private Network (VPN) available to students so that those logging in from countries where there may be stricter limitations on internet usage put in place by their respective governments may continue to learn uninterrupted (Office of the Vice-Provost of U of T). These resources were initially meant to help U of T students with online learning during the pandemic, but can also be used to promote and support distance learning in the future.

The University of Toronto has also taken steps to address the assessment challenges of learning physics online. A variety of measures such as vaccine mandates, the adoption of the UCheck platform for self-reporting COVID-19 symptoms and mask regulations have allowed for the maintenance of the majority of in-person lab activities for physics courses, albeit with reduced capacities for many physics courses (Rogerson). As a result, many U of T physics students have been able to enjoy the hands-on learning experience of conducting experiments with the large array of equipment available in U of T labs. Despite the cancellation of a number of exams near the end of the Winter 2020 semester, U of T was well adjusted to conduct modified online exams from the Fall 2020 semester onwards. Moving forward, the university now plans a complete return to normal as of May 1st, 2022 (Office of the Vice-Provost of U of T).

As evidenced in the testimonials from members of the University of Toronto physics community, many individuals found that it was still difficult to foster meaningful connections between students and instructors while online, despite the various strategies implemented. Inconsistency between delivery methods and a lack of face to face interactions were main challenges highlighted by certain members of the physics community. As a result, many individuals felt that studying physics throughout the pandemic has been more challenging academically. On the other hand, there was disagreement between those who responded to the survey on whether or not studying physics online at U of T has been more challenging logistically, as some may have preferred the self-guided nature of online learning while others may have felt left behind. This highlights the divide between those who preferred asynchronous activities over synchronous ones. Overall, however, a majority of individuals displayed disagreement over the success of the strategies implemented by U of T to navigate the pandemic. The main advantages which were highlighted though showed that strategies such as recorded lectures and redesigned exams were not without benefit, and point to the potential success of distance learning through U of T in the future.

COVID-19 AND PHYSICS RESEARCH

WRITTEN BY JASON ROCK

ADJUSTING TO LIFE AT HOME

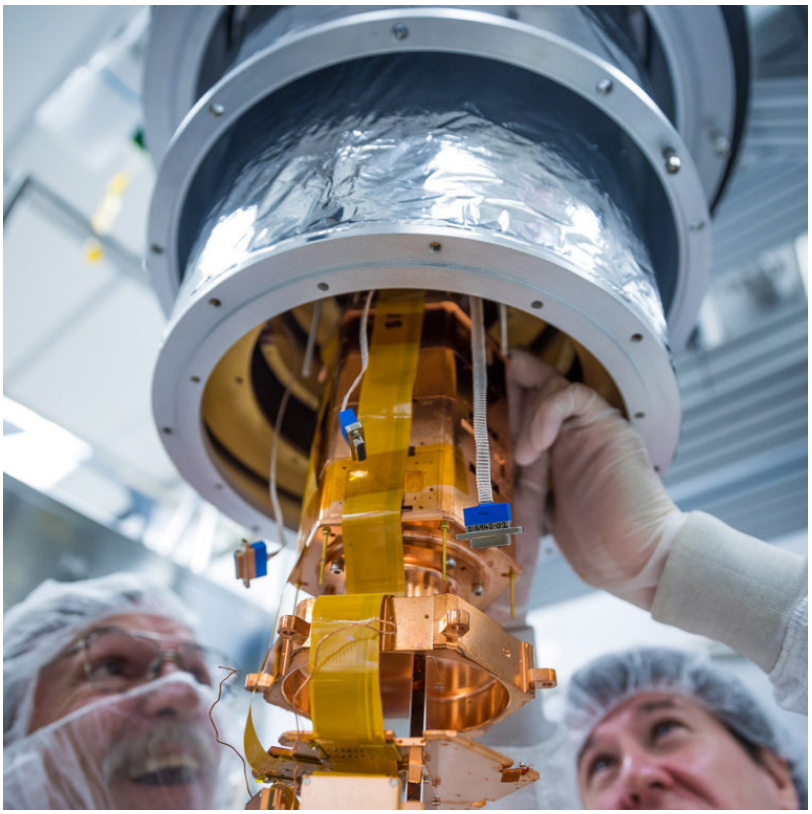
In March of 2020, human interaction seemingly came to a screeching halt with the declaration that SARS-COV-2 virus had become a global pandemic. When the possibility of contracting an un-researched and potentially deadly virus became a very real possibility, leading scientists believed it safest to encourage all non-essential people to remain at home.

With the sudden onset of this news, ramifications began to trickle onto, well, everyone. For physicists, this meant the inability to return to their experiments regularly. At the start of the pandemic, labs deemed non-essential were closed in an effort to prevent the spread of disease. This made specialized technology inaccessible and essentially resulted in a research halt. However, this standstill doesn't encompass all research. As many physics labs were deemed non-essential, vaccine research ramped up in order to get closer to finding a solution to return to normalcy.

In the United States, research projects not related to COVID-19 decreased by nearly a third, and research papers were being published and submitted at a slower rate than normally seen pre-pandemic (Randall 10). This decrease can be attributed to the lack of in-person collaboration, as well as the difficulty of visiting experiments in-lab regularly. In an April 2020 survey, researchers stated an average drop of ~7 hours each work week compared to pre-pandemic hours. However, when asked to complete the survey in January of 2021, the number had only suffered roughly a 2 hour decrease, indicating a gradual return to normalcy. However, despite an eventual shift to pre-pandemic hours, many researchers maintain hourly work, and their livelihood can depend on working their allocated amount of weekly hours (Randall 10). Dr. Liboiron, the head of a plastic pollution monitoring lab in Canada discusses how she ensured that her researchers maintained their hours completing work that didn't involve working in person. She notably mentions how the funding for future projects transitioned to be wages for her employees during the pandemic, nonchalantly mentioning, "We will miss deadlines...It's an easy decision, even if it results in less science" (Giaimo 1). This underscores her humanity despite delays, she is firm on putting researcher wellbeing above the research itself.

In his article, Randall discusses how in the research realm, the pandemic's repercussions felt by female researchers and researchers with young children were disproportionate compared to their male counterparts. Tatyana Deryugina from the University of Illinois discusses the long term ramifications of this demographic disadvantage, stating that, "There is a risk academia will permanently lose talented researchers unless countervailing policies are implemented" (Randall 10). At the beginning of the pandemic, childcare took a shift that required parents of young children to adjust their routines. With teaching shifting to a virtual basis, and daycares closing as a result of controlling the spread of disease, many researchers became homebound in a way that made it difficult to be productive in a conducive manner. This lack of productivity, in addition to the looming impacts of the pandemic can manifest in a psychological toll on researchers, which may result in an overall disinterest for projects and experiments.

While it is fair to say the pandemic's effects on research have affected many scientific disciplines similarly, an interview with Physics Professor Miriam Diamond highlights how COVID-19 has affected physics research at the University of Toronto:



A close up of the SuperCDMS detector. Image: (Institute of Particle Physics)

Jason: First off, tell me about the research projects you are working on.

Prof. Diamond: I am currently working for the SuperCDMS project and the MATHUSLA project. SuperCDMS stands for Super Cryogenic Dark Matter Search and it is a project on detecting dark matter particles. MATHUSLA stands for Massive Timing Hodoscope for Ultra-Stable neutral particles and it is a proposed detector to sit on the surface of the Large Hadron Collider (LHC) at CERN. This detector will detect long lived particles being born at the LHC.

Jason: During COVID-19, how has the time commitment around these research projects changed?

Prof. Diamond: Well before COVID-19, I spent around two thirds of my time on SuperCDMS and one third of my time on MATHUSLA. Within each project, I spent around half my time on developing simulations and the other half on project operations. During COVID-19, operations went to a halt and almost all my time was spent on developing simulations.

Jason: I suppose developing computer simulations is a work from home friendly task.

Prof. Diamond: Definitely! However we can't just do simulations forever. It is important that we get experimental data, which has been really tough lately.

Jason: On a similar topic, has a decrease in face to face activities limited the progression in your lab?

Prof. Diamond: It has been really bad. For MATHUSLA and SuperCDMS, we are behind almost a year! Navigating around COVID related restrictions is hard, the order in which operations and certain laboratory processes can't easily be done in reverse.

Jason: Shifting gears a bit, have acquiring and spending grants or funding changed since the start of the pandemic?

Prof. Diamond: Fortunately there hasn't been a decrease in available grants. However it is important to note that grants usually have a spending time limit. This means you are only allowed to spend grant money within a time window. Many grants during the pandemic allowed for a one to two year extension on this time limit which has been really helpful. It is also important to note that since experiments and research has been delayed, so have the progress of graduate students. During this delay, they still need to be supported financially for the extra year or so that they will be working.

SUPPLY CHAIN WOES

Certainly every person who lived through the COVID-19 Pandemic will recall in their own way, the once fully stocked shelves of toilet paper suddenly being barren. Whether you were on the panic buying end of the toilet paper, or unable to purchase toilet paper as a result of other people purchasing as much as they could fit in their cart, it exemplifies the effects of a supply chain issue caused by an external factor (e.g. a global pandemic). While procuring toilet paper was more of a surge of demand not being met by a typical supply, the supply gaps faced by physics researchers are much more profound than a supply demand mismatch.

In addition to research labs closing as a result of managing the spread of disease, many labs were unable to maintain their day to day operations as a result of being unable to procure the materials needed for experimentation. Charlie Veith, a stakeholder in the National Science Foundations Nanotechnology facility site discussed how acetone has become increasingly difficult to procure as a result of the pandemic (Feder 20). Aside from cleaning, acetone is considered vital for lithography. Similar to a typical pandemic consumer, masks, gloves, and other personal protective equipment (PPE) necessary to conduct lab work has become difficult to source, causing researchers having to source different vendors and purchase whatever is available, even if it may not be the exact product that researchers may have used previously. Researchers are going to such lengths to ration supplies, and to reserve PPE for situations where contamination could impact experimentation.

Guido Pagano, a researcher of quantum information processing at Rice University described how the closure of his lab during lockdown was actually the least of his roadblocks. Upon reopening of the lab, the wait time for a high-power ultra-violet pulsed laser was threefold the pre-pandemic timelines (Feder 21). Given that the laser is an integral part of his research, it has caused a two month delay to turn into a twelve month delay. In an ode to mitigate this delay, he is making an effort to borrow this device from other groups. Pagano had insight that the laser would take longer than usual, but oftentimes, issues with the supply chain can be unforeseen, and unpredicted. For example, an aluminum board meant to mount optics which should have taken 6 weeks, took over 4 months as a result of material and staff shortages (Feder 21).

These shortages result in researchers having to devise workarounds, which evidently are devised in an attempt to not jeopardise the data or experimentation, but do run the risk of this occurring. Daeywon Lee at the University of Pennsylvania runs a research group to develop biomedical applications. The research was centred around encapsulating mRNA for vaccines, and they required polydimethylsiloxane (PDMS), an elastomer required for the device (Feder 23). Due to supply chain issues they were unable to source the PDMS, and as a result, researchers were required to find other viable elastomers in order to continue with their research. They were able to identify and source a substitute, but Lee states, "Is the behaviour impacted by new material? When we try to publish, there will be questions" (Feder 23). Ultimately, it seems that researchers are trying to balance maintaining operations, without surrendering any experimental

integrity, however given the nature of the substitutes, there is no guarantee that this might occur.

It can be risky if a laboratory only has one supplier for their materials, as supply chains are only harmonious if all parts move as anticipated. Analogous to an assembly line, if the prior part is not ready, the rest of the process halts until it is ready. As soon as there is one delay, the supply chain begins to fall apart. For physicists, when a typical supplier is unable to provide the desired product, they turn to other vendors, which are able to charge a significant premium, which oftentimes labs have to pay in order to continue being operational. Many of these labs additionally face funding deadlines, that many of these shipping estimates may exceed. As a result, researchers have no other choice than paying extreme premiums to expedite their products to ensure they don't forgo their funding (Feder 22).

Supply chains for the materials required for scientific research are often called "Just in time" (JIT) supply chains. These supply chains are characterized by producing products only when they are needed, and not keeping any stock of them otherwise (Zimmer 1). The intention with this process is to prevent loss by keeping stock that will not be purchased, has the opportunity to expire, all while decreasing holding costs (Redwood 1). This would make sense typically for highly specialized products or machinery that may be typical within a laboratory. However, this is a suboptimal model during a pandemic, where many of the raw materials required to facilitate the JIT supply chain are unavailable or heavily delayed.

If researchers are creative, and fortunate, they might be able to source locally, procure from other labs/research groups, or pay premiums with suppliers who have availability (Zimmer 1). This all takes extended periods of time to work out and establish, which impacts negatively on experimentation and funding.

During our interview, Physics Professor Miriam Diamond had some professional insight on how supply chain issues affected her ability to continue her research:

Jason: On the manufacturing end, have getting specialised items or materials taken longer than usual recently?

Prof. Diamond: For SuperCDMS, certain silicon chips and FPGAs were extremely hard to get. The lead times on ordering these items have increased from weeks to months. One of the optical fibre manufacturers for the MATHUSLA project recently shut down its operations for a certain specialized fibre. Fortunately we have other vendors to work with. It doesn't help that the prices of everything have gone up.

Jason: Are there any other kinks in the supply chain that have affected the lead times for ordering parts?

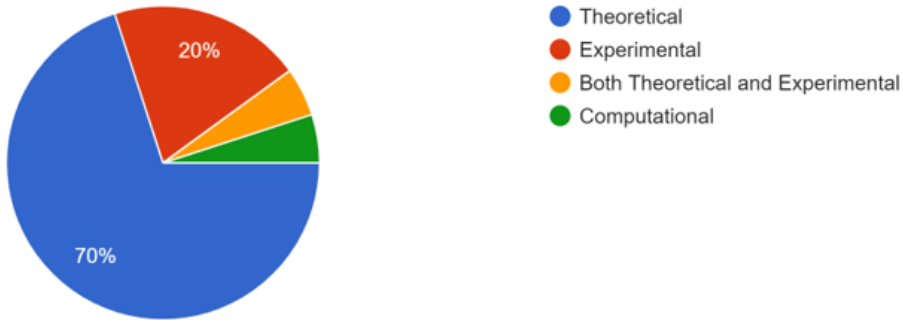
Prof. Diamond: Actually yes, the delivery trucks that bring liquid helium to the SuperCDMS lab in Sudbury halted deliveries during the height of COVID-19. Liquid helium is an extremely crucial component for the operation of SuperCDMS. As well, the vaccination policy at laboratories made it so many unvaccinated delivery drivers could not enter the laboratory premise.

REFLECTION OF THE SURVEY

In the survey we distributed, we got a handful of graduate students to respond. In the physics department, graduate students spend the majority of their time on a research project under a professor. This is an important metric to keep in mind as different types of research can be done at home while others require a dedicated laboratory space. Our survey results seem to mirror the issues highlighted in this section. The following responses were rated on a likert scale with 1 being strongly disagree, 2 being somewhat disagree, 3 being neutral, 4 being somewhat agree and 5 being strongly agree.

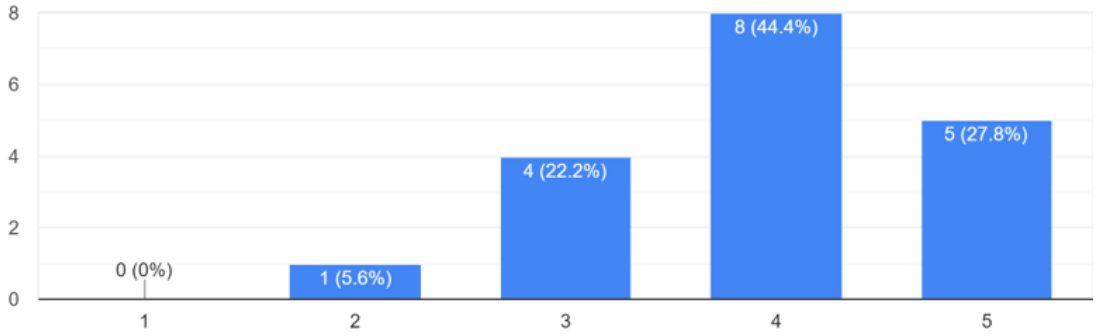
What is your type of research? [Skip if you are not a researcher.]

20 responses



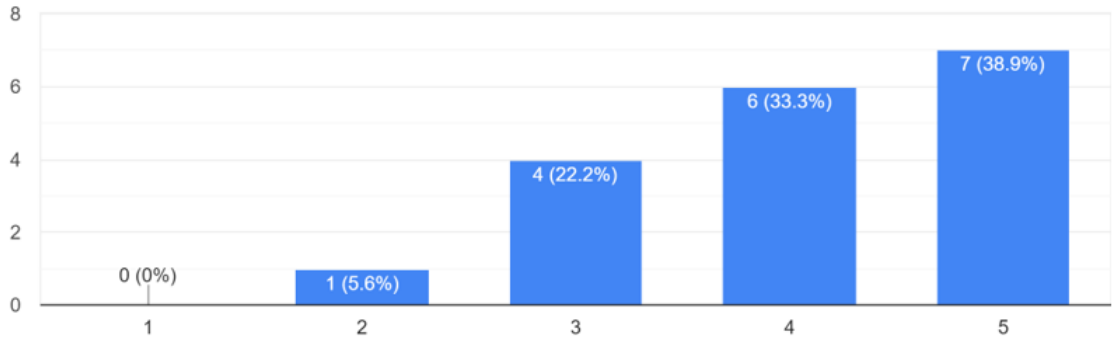
"COVID-19 has had negative affects on research progress in my group or lab." [Skip if you are not a researcher.]

18 responses



"A decrease in face-to-face activities has negatively affected the progress in my group or lab." [Skip if you are not a researcher.]

18 responses



POLICY CHANGES FOR THE FUTURE

So far, we have discussed many ways how COVID-19 has affected the progression of research in physics and science abroad. Although COVID-19 restrictions are being lifted along with a near back to normal work life, it is important to discuss how policies could have prevented many complications for researchers during the last two years.

I asked professor Diamond about if any new policies or services arose during the pandemic. Her response:

Prof. Diamond: It was really nice to have various remote services such as financial services, faculty meetings, seminars, and colloquiums be remote. During the pandemic, we realized that we don't need to be in person for these services and events to be productive. As well, the University of Toronto Faculty Association (UTFA) helped professors and faculty negotiate with the university to transition from in-person teaching to online teaching since in-person teaching during the pandemic is quite an unsafe working environment.

Jason: If you could implement one or more policies at UofT, what would it be?

Prof. Diamond: I would love a policy to allow more working from home in the future. Certain activities don't require being in the office such as grading assignments or class preparation. As well, some theoretical researchers may not need to be in the office since most work can be done remotely. As well, I would like to see a policy for continuing capacity restrictions in lecture halls and classrooms.

FINAL REMARKS

It is clear that there are a great amount of similarities between the survey results, professor Diamond's interview, and additional research articles. Indeed, it is no surprise that COVID-19 has affected many aspects of scientific research. With numerous health and safety restrictions in place, various research groups have been put to a halt. A decrease in face to face activities along with social distancing protocols have naturally slowed down collaborative group progress. Given that COVID-19 is a world wide pandemic, factories and manufacturing plants for specialized materials were affected by the very same reasons above, thus reducing production output. With abiding by COVID-19 restrictions and experiencing supply chain delays, many research groups are behind schedule by a few months to a year.

What can we learn from these last two years? Certain research activities can be done remotely such as simulations and theoretical analysis. Prior to the pandemic, these activities would likely be done in the office despite it easily being done remote. The pandemic has normalized the work from home model which should still be utilized moving forward. However, many experimental research activities must be done in specialized laboratory environments which unfortunately have no work around with health restrictions.

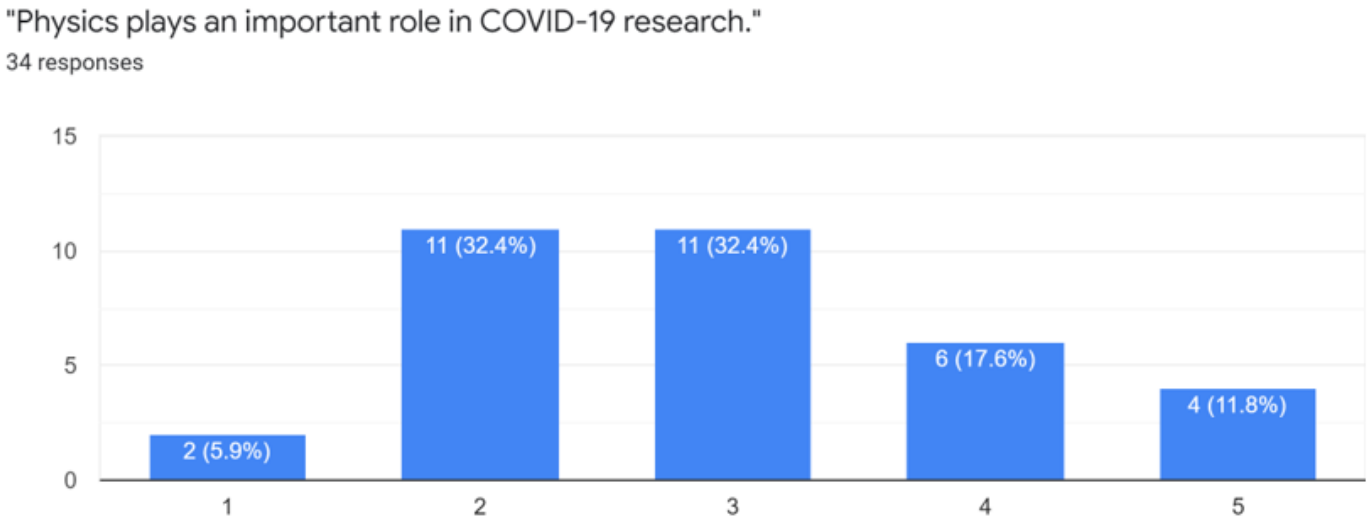
APPLICATIONS OF PHYSICS IN COVID-19 RESEARCH

WRITTEN BY MARIAM ELSAYED

As defined in Britannica, physics is a science that deals with the structure of matter and the interactions between the fundamental constituents of the observable universe. When we think of the branches of physics, quantum mechanics, nuclear physics, and electromagnetism come to mind. However, the boundaries of physics are not rigidly defined. Physics intersects with many interdisciplinary areas of research, and also often advances new technology.

How could physics play a role in the fight to end the COVID-19 pandemic? In this section, we look at various examples of how scientists use physics to better understand the mechanisms of the pandemic, and how familiar our sampling of the physics community is with these efforts.

PERCEPTIONS



To gauge the public's perception on the topic, we asked our survey participants to rate the following statement from 1 (strongly disagree) to 5 (strongly agree): "Physics plays an important role in COVID-19 research". 34 responses were received, with most selecting 3 (neutral) or 2 (disagree). The following optional short answer question asked participants to elaborate on their previous choice. 27 responses were received and were grouped as follows:

- 5 participants mentioned aerosol models, 2 mentioned biophysics loosely without saying exactly how it contributes specifically.
- 11 participants were not sure: They can't see how physics could play a role in COVID-19 research, or do not have enough experience to make a decision.
- 6 participants recognize that physics could play a role in research, but are say other areas of science such as the medical community contribute a lot more
- 3 participants said physics should not interfere with COVID-19 research, saying that it should be left to epidemiologists/virologists/medical doctors.

A lot of COVID-19 research in physics comes from the biophysics branch. Biophysics as a field is relatively new and is currently underrepresented. As evidenced in our survey, most respondents were not familiar with the branch, possibly because they have not studied it. There are both structural and perceived barriers for entry into the field. Physics students who might be interested in the field often wonder to what extent they need to "learn biology", a foreign subject outside of physics. Biological physics courses are often offered in the upper years, making it difficult to engage with the subject more meaningfully (National Academies of Sciences, Engineering, and Medicine 216).

U of T's physics department is on the right track, offering a 200-, 300-, and 400-level course on biological physics, but problems to do with the physics of living systems aren't presented in core physics courses (electromagnetism, thermal physics, classical mechanics) like more traditional problems in nuclear physics and high energy are. The purpose of this section is to raise awareness to what physicists have contributed to research surrounding the pandemic, not only within biophysics, but also in treatment, medical devices, and community contributions.

DEVICES

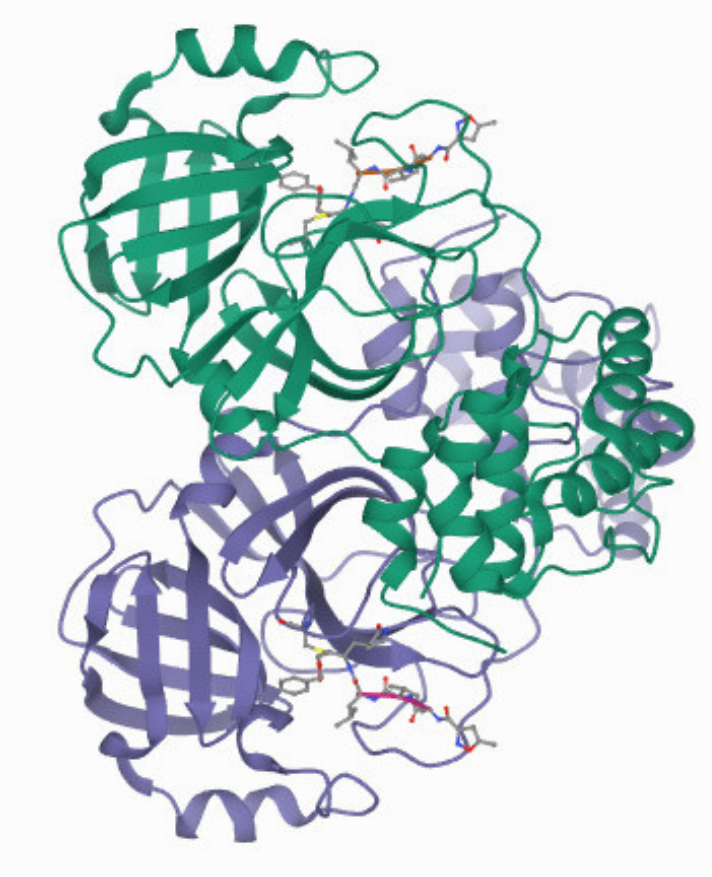
In the past couple of years, we've seen the increased use of non-contact thermometers. They are used to accurately measure human body temperature without the risk of cross-contamination or the need for close contact.

Professor Desmond Gibson at the University of the West of Scotland's School of Computing, Engineering and Physical Science founded the Institute of Thin Films, Sensors and Imaging in 2014, which specialises in the development and research of thin films for medical devices, sensors, electronic devices, and more. "Sensors are used to absorb infrared radiation and embedded in a chip which gives a true measurement of human body temperature" Gibson explained.

More than 12 million orders for the chips have been received from around the world since the beginning of the outbreak. The institute has been working with Semefab, a semiconductor foundry, to increase the production of these chips and to bring the product to the market (Gibson).

VIRAL STRUCTURE RESEARCH

X-ray crystallography is a technique commonly used in biology to reveal the structure and function of biological molecules. This technique stemmed from the work of physicists such as Max von Laue, Wilhelm Roentgen, and William Lawrence and William Henry Bragg.



First high-resolution crystal structure of COVID-19's main protease (Mpro) determined by Zihe Rao and Haitao Yang's research team at Shanghai Tech University
Image: (https://www.rcsb.org/structure/6LU7)

Using X-ray crystallography at the Shanghai Synchrotron Radiation Facility, scientists at ShanghaiTech University uploaded the structure of the main protease Mpro of the SARS-CoV-2 virus to the protein data bank in February 2020 (DOI: 10.2210/pdb6lu7/pdb) and published an article two months later in Science (Jin et al. 289).

However, X-ray crystallography requires the molecule to be crystallised, which is not always possible. Cryogenic electron microscopy (cryo-EM) is a technique that images the molecules directly by keeping them on a grid and flash freezing. It was pioneered by biophysicists Jacques Dubochet, Joachim Frank, and Richard Henderson, for which they received the 2017 Nobel Prize for Chemistry.

Using cryo-EM, the structure of an SARS-CoV-2 trimeric spike glycoprotein was found by biochemists Daniel Wrapp and Nianshuang Wang and published in Science in 2020. This spike protein lets the virus bind to host cells, making it a key target for potential therapies and diagnostics. "Without cryo-EM, it may not have been possible at all," said Jason McLellan, an author on the paper, to Physics World magazine.

TRANSMISSION

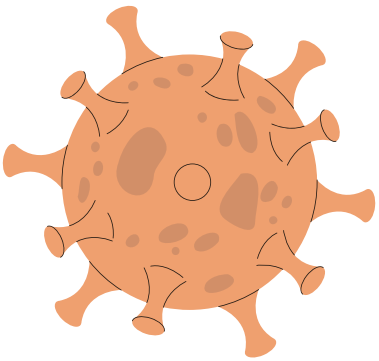
More locally, Professor Swetaprovo Chaudhuri from the University of Toronto Institute of Aerospace Studies (UTIAS) predicts the spread of COVID-19 through droplets ejected while coughing or sneezing. He recognized a similarity of the spread of droplets with his usual research, that being modelling the motion of finely sprayed fuel in a jet engine combustor, since the same fundamental physics is involved, albeit with different specific conditions of respiratory spray.

His team measured how suspended droplets evaporated from an acoustic levitator, which is a device that uses sound waves to cause droplets to float suspended in the air. One of the results showed that respiratory droplets last longer and therefore travel faster in cool, humid conditions rather than hot, dry conditions. They published their results in the journal Physics of Fluids in 2020, being the first model that utilised the structure of a chemical reaction mechanism to connect the pandemic evolution equations with respiratory droplet lifetime by first-principles modelling of the reaction rate constant (Chaudhuri 063309).

Predicting the exact spread of COVID-19 is not the purpose of this model, but rather to test out a first-principles modelling approach based on fundamental physics. Since most pandemic models are based on rate constants determined by fitting available data from previous outbreaks, this modelling approach could introduce new methods in epidemiology that lead to more accurate predictions in the future.

TREATMENT

While biophysics is focused on the understanding of biological systems in terms of physical principles, medical physics focuses on the practical aspects of physics in methods and techniques in medical imaging and nuclear medicine. Medical physicists are discussing new treatments for COVID-19 using low doses of radiation. This is used to reduce inflammation since other anti-COVID drugs have no effect on COVID-19 pneumonia (Pandey et al. 62).

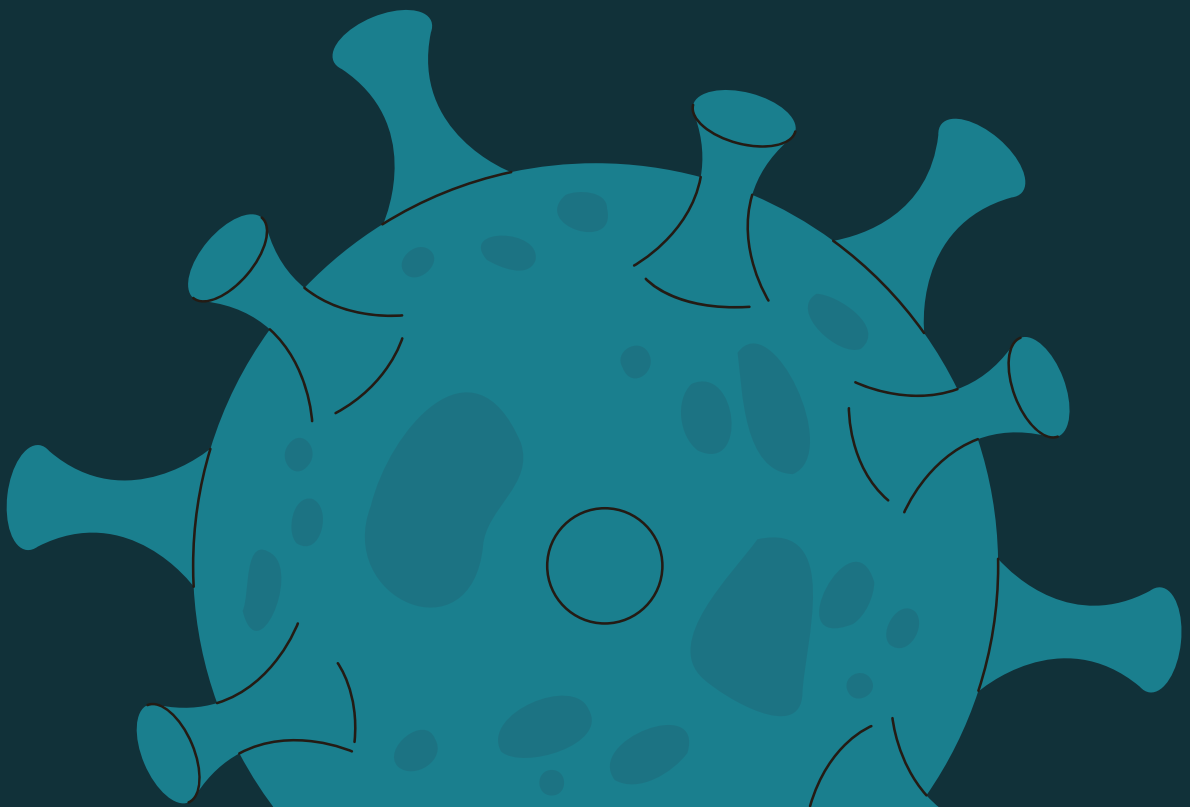


Physics has many interdisciplinary applications and has both directly and indirectly contributed to COVID-19 research. Having scientists from different fields come together and solve one problem could lead to more ideas and innovation in their respective fields and thus be encouraged. To do so, physics undergraduate programs should provide a wider variety of subtopics and problems in core physics courses.

CONCLUSION

& REMARKS FOR GOING FORWARD

We'd like to take this opportunity to thank you for engaging with our magazine. We'd also like to extend a thank you once again to those who participated in the survey and made themselves available to be interviewed. Despite the small sample size of the survey, we feel it still serves as an excellent starting point to inform discussions on the topic of COVID-19 and the physics community. Moving forward, we are certain more challenges and breakthroughs will continue to arise as the recovery from the pandemic is still an ongoing process. Given the opportunity, we are certain that a reprisal of this conversation, with perhaps a survey spanning a larger data pool, would be beneficial in further analyzing how far the physics community as a whole has come since early 2020. We hope this magazine can be a useful tool for evaluating the impacts of the pandemic on members of the physics community, as well as a window into the response and strategies implemented by the University of Toronto to deal with these changes. Above all else, we hope you stay safe and sane as we gradually return to normal.



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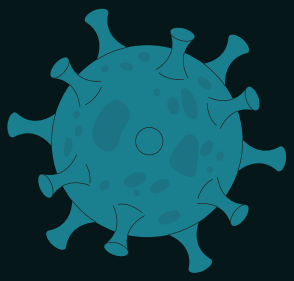

THANK YOU FOR READING!