

Testimony before
The Subcommittee on Research and Technology
Committee on Science, Space, and Technology
United States House of Representatives

**Hearing Titled: The Impact Of The Covid-19 Crisis On University
Research**

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September 9th, 2020

I would like to thank Chairwoman Stevens, Ranking Member Dr. Baird and the entire Subcommittee on Research and Technology for giving me the opportunity to testify today and for allowing the space to exist for discussion on the impact of the COVID-19 pandemic on University Research. I am both honored and humbled to be able to offer my viewpoint as a graduate student. I hope that this testimony provides stories and voices of graduate students so that you can gain insight into how our lives have rigidly shifted in these challenging times.

After completing my undergraduate degree at Kenyon College in Ohio, I joined Carnegie Mellon University as a Ph.D. student in the Department of Physics two years ago. My work lies in the understanding of novel materials and the fundamental principles that govern their properties in order to introduce them into functioning electronic devices for memory storage, quantum computing, and biomedical applications. I am an experimentalist, meaning my research relies on my ability to operate complex instrumentation in person within multiple labs, cleanrooms, machine shops, at Carnegie Mellon as well as the Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California. For the past two years, my work was funded by the Department of Energy (DoE), and is currently funded by the National Science Foundation (NSF). I would also like to thank the full committee for supporting the mission of both the DoE and the NSF and hope that even more students in the future will be funded by these incredible agencies.

My doctoral research is aimed at designing materials as thin as a single layer of atoms, such as graphene, and studying and exploiting their properties for real world appliances. The working area of my devices is typically half of the thickness of a human hair. This line of research has the potential to revolutionize how we live our lives. It has already made significant advances in quantum computing and biomedical applications. In order to further my research, I must use state of the art technology that allows me to synthesize and measure such materials and devices. I can only create these samples and perform measurements at nanofabrication facilities, machine shops and facilities such as LBNL in person. I firmly believe that not only will my work serve the lives of people in the world for every day work but it will progress science and lay the foundation for future scientists.

In May 2019, I was at LBNL for the first time working at the MAESTRO beamline at the Advanced Light Source Synchrotron (ALS), a DoE facility within LBNL. I was learning how to operate a complicated tool from the scientists who built it—a rare opportunity. My collaborators from Aarhus University in Denmark had made the trip to train me such that we could work together to further our knowledge of graphene. It is almost impossible to conduct such training in a virtual setting. LBNL was the best place for me to not only learn but also network and see the cutting edge research being done there. Since then, my day-to-day research operations included collaborating with many undergraduate and graduate students like myself, professors, and technical staff where I needed to be physically near people in my laboratory and machine shops to perform the necessary job. All of my research facilities require multiple people to be in an enclosed environment for long periods of time. We all use the same tools and, at times, need to be overlapping in space by using the same gloves and viewports on instruments. Today, none of this work can take place without extreme caution to prevent the spread of COVID-19.

For the school year leading up to March 2020, I was preparing material samples for measurements at LBNL to use the angle resolved photoemission spectrometer with nanometer x-ray spotsize (nano-ARPES) endstation at the MAESTRO beamline. This style of instrument can only be found at a handful of facilities world wide. It is understood that nano-ARPES is the state of the art, and cannot be replaced by any other at present. In order to operate it one needs to learn from the staff scientists at LBNL by attending multiple measurement runs. The work I do year-round is in preparation for in-person operation of this instrument but the experience and usefulness of traveling to LBNL does not end at measurement—LBNL is also a gathering place for the best scientists in the world, just as any other national lab. Hundreds of scientists apply to get time on the MAESTRO beamline, and only a selected few get to do so. The researchers who travel to or are permanently located at this facility are amongst the very best in their fields. Learning from them is integral to my research and career advancement. It is a crucial learning experience of my Ph.D. and helps expand the horizons of my knowledge of Physics. It is also an opportunity to get to know these scientists and grow my professional network progressing my understanding of and network in Physics. My ultimate goal is to work in a facility such as

LBNL for an extended period of time, either as a graduate student or postdoctoral researcher. Without attending in-person measurement sessions, my chances of attaining such a position are low.

However, this wasn't the only opportunity lost to the pandemic. In March, I was also ready to present my research to the scientific community for the first time at the American Physical Society (APS) March meeting—the world's biggest conference for condensed matter Physics, that hosts over ten thousand researchers each year. Upon arriving in the host city, Denver, to attend the conference, I found out that the meeting was canceled. Soon after that, all in-person activities at Carnegie Mellon University were canceled and all non-essential travel was suspended indefinitely. Both my presentation and pre-LBNL preparations were canceled resulting in a great loss in scientific opportunity and personal development. Even today, I am unsure whether I will be able to return to LBNL, let alone measure the samples I want to measure.

Work in my field requires an in-person collaborative environment, and is also heavily reliant on training. In my lab, I train new undergraduate students every semester who eventually become fluent in the field and gain research experience by collaborating with me on various projects. These are students who wish to pursue a doctoral degree themselves and this exposure to research helps them gain a better understanding of where their interests lie. Ever since our lab shut down in March, I have not been able to work with them. Not only have they lost the opportunity to learn, explore, and refine their skills, my research productivity has been severely impacted as well.

From the day we had to shut down our lab, my advisor and I anticipated that I would not be able to make much progress on my research until we regain access to on-campus facilities. Between March and May, my research work was constrained to only performing data analysis. While every experimental physicist must analyse data, hardly ever is it the only research work you're engaged in. For those two months, I barely accomplished what I would normally do in a week.

So when CMU invited proposals for phased reopening of research labs in May, our lab soon began the application process to bring ourselves back to campus during CMU's *return to research test phase*. Apart from devising a plan to maximize safety of my labmates and myself, I began buying PPE equipment, including face shields, face masks, two sets of gloves, lab coats, pants, and hand sanitizer. We were chosen to be one of the first labs back on campus in June. For a period of almost 3 months, I could not perform any experiments, slowing progress on my research project. However, reopening by itself was not sufficient for most of my friends whose labs also reopened. Prior to the pandemic, most students used public transit to commute to and from campus, but a reduction in frequency of the Port Authority buses made it difficult for those students to commute. While I was fortunate to own a car, the majority of my fellow graduate students did not. Since our lab reopened in a limited capacity, my daily routine has changed significantly. When I arrive on campus, I have to change into lab-only clothing (including lab coat and pants) that stays on campus. I then don gloves and wipe down every surface I touch throughout the day. To leave the lab and go anywhere but my office, I need to change back into the clothes I wore to campus and, upon returning to my office and lab, I must change back into lab clothing and follow sanitization protocol to re-enter.

For two months since June, I was the only student working in my lab where, in the past, there were three graduate students and four regular undergraduate students. My newly added responsibilities were beyond the scope of my research because I was maintaining instrumentation that I had never used and wasn't even relevant to my ongoing project. My labmates had to move from being research assistants to being teaching assistants to preserve their stipend and tuition support (as research related to their projects could not be conducted remotely), while I was able to stay on as a research assistant by performing data analysis during this period. Without my fellow labmates, I had to learn to establish the pandemic routines of working in a lab. I was the sole person in my lab allowed into the cleanroom for nano fabrication instruments that is used on nearly every project in our lab. This meant that I was in charge of operating these instruments for multiple projects. On top of the unexpected loss of productivity, I had to absorb other work as well.

As people have started to return to the lab, maintaining a six-foot social distance has been difficult because we are in the midst of building a new state of the art instrument in-house to advance the lab's research capabilities as a whole, and that requires multiple people to hoist, turn knobs, and screw in different components. Every part of our lab is a common space that is used by multiple people every day. Gradually, we have been able to get all graduate students and a postdoctoral researcher back to the lab. All of the undergraduate students trained in the past two years are still not able to come. Furthermore, the ongoing training is now nearly back to square one, where we have to now explain procedures remotely or from a distance.

When I come into the lab, I am excited to be productive and work hard, but by the middle of the day I become exhausted from dodging all of the potential COVID-19 contact areas. I work in a state of fear as I constantly wash my hands, apply hand sanitizer, and clean surfaces that I have touched. I trust my labmates to make the right decisions about social distancing, but I worry about my trips outside of the lab to go home or get coffee. I now go to my lab, bring lunch, make coffee in my office and minimize going outside of those two spaces. Every person I meet in the cleanroom and surface that I touch, a small thought arises in my head: *Is this the space where I contract COVID-19 and bring it home to my housemates?*

Now that we have had time to adjust to research, it feels that many months have passed but with only a few weeks of work to show. We have spent many days creating remote access for our instrumentation but not every process can be done remotely, no matter how hard we try. I currently have no plans for returning to LBNL. The facility has reopened for remote non-ideal measurements and I am forced to adapt, else I will be without the data I need to further my research. Even with the measurements I can do, the remote experience does not provide the same exposure to me as an early career researcher as in-person measurements do. I believe that we, as a scientific community, adapted the best we could, but all our efforts towards boosting efficiency in the long-run of COVID-19 could have been spent on the actual research itself.

That said, I am not alone in my hardships. I have heard and witnessed many fellow graduate students go through similar experiences and more. A fellow graduate student put it well, “*Graduate school is harder than most imagine. It is hard during the best of times and we are far from the best of times.*” As another Ph.D. student put it, “*under pandemic research conditions, all parts of grad school that make it bearable are removed and we’re left with the parts that are frustrating and emotionally draining.*” all while being home to isolation. The mental toll we are taking is multivariable and takes form in many aspects of our lives. Graduate students are more than just researchers—we are a linchpin in the entire higher education system, we conduct groundbreaking research, drive day to day operations of our labs, and teach and mentor undergraduate students. When it comes to early career researchers like myself and other graduate students, we need a large scale boost in funding, the stakes are nothing less than the U.S. risking losing a generation of talent.

During this time, my mental health has been significantly impacted as I live in malaise. The COVID-19 pandemic is constantly on my mind, my thoughts are often clouded by concern for the lives of my family, friends, and myself. Furthermore, being a Black man, I have been heavily affected by the Black Lives Matter (BLM) movement that dominates my news feed, interactions with family and friends as well as within academia. I do not know how to process such events as the videos revolving online and the protests when I am alone in my house. The continuous stream of information about BLM, COVID-19, widespread job loss and economic drops has demolished my productivity.

My experiences are hardly representative of graduate students across Carnegie Mellon let alone across the country, the graduate student community consists of people in a wide range of life stages and backgrounds. How the pandemic influences graduate students is a dynamic problem with the variables being both time and the student. I believe the most immediate group of graduate students who need help are those who are graduating soon, with uncertainty looming around their future in research. These students are especially hurting because they are looking to finish up projects that, for some, cannot be performed remotely. A graduate student at CMU’s

School of Computer Science expressed concern that their graduation date may be pushed back which would result in them needing potentially unavailable funding. Another student in the College of Engineering has already had their graduation date pushed back from the end of the summer to the end of the fall semester so they can keep searching for jobs and have some financial security through their Ph.D. stipend until they can find an employer. The job market for students has dried up quickly over the last few months. One graduate student at CMU was in the middle of job interviews when they were all cancelled and they had to begin their job search again. Many students have voiced concerns about not being able to find a job for post-graduation because they have lost summer jobs and internships, many of them only hearing from their future employers in April, only one month before their date of employment.

Many students who have already graduated are continuing their studies as postdocs in the lab they graduated from. This, in principle, allows one to refine their understanding of their work but in reality it only narrows their chances of evolving their careers. The reason one would take a postdoc is to broaden their understanding of their field and set them apart from their advisor. Ultimately, to get a job in academia or a research lab, one must establish that they are the leading expert in a unique and interesting area of research, not just a replica of their advisor. However, the disruptions in the academic job market has made that almost impossible for many, and has the potential to reduce the number of people who continue in science, ultimately leading to the loss of valuable talent.

These more experienced students are in need of funding which can be accomplished by supporting the *Support Early-Career Researchers Act* which will greatly assist these students by allowing them to be funded and bring their talents to other research groups and eventually take on research roles, whether in academia, in the private sector, or in national labs like LBNL. We have heard from one student who in particular has decided that, due to COVID, he will not be pursuing an academic job. He, like many other students, is worried about the stagnating job market for tenure track professorships. With universities and various industries announcing hiring freezes, there are significantly more eligible job applicants than the jobs available, often

pushing graduating students outside of STEM research.

Similarly, for early stage graduate students COVID-19 is already negatively affecting their research and collaboration prospects. It is only early in one's Ph.D. that they explore different research problems and settle on what they would pursue for the rest of their time as a doctoral student. The pandemic and resulting restrictions have hindered their ability to do so. For people who work in my lab and many other labs at Carnegie Mellon, this is extremely clear: they have yet to be trained, are unable to make connections to labmates and professors, and have limited or no access to facilities. Currently at CMU, the nanofabrication laboratory, which holds the majority of the essential tools that experimentalists like me need to do their work, is limiting their number of people allowed in their facilities. Furthermore, trainings that I would normally conduct myself in successive sessions, are now restricted to only being conducted by cleanroom staff who have very tight schedules and are only allowed to work for four days a week.

In speaking with a first year graduate student, he voiced concerns about his experience so far while recognizing the inherent limitations of what the university can do about them. He is allowed on campus for his single in-person class and has special permission to work in my lab while the rest of his cohort can only attend in-person classes. Students who are in the early years of their Ph.D. have had difficulty finding time to do research. A second year Ph.D. student was taking classes, teaching a course, and trying to find time for research had her summer dreams erased by COVID-19. *"I was really looking forward to the summer; it was the first time [in my graduate career] that I could focus on research and really dive into it but it never happened,"* she said. Instead of learning the vital fundamentals of her research, she returned to the lab to find that the instrument that she was in the middle of training on had broken during the duration of the quarantine. Now that she is taking courses again, she is trying to learn how to fix the instrument remotely.

Apart from the first year and mid-career graduate students, I have heard many stories of students who are unsure if their knowledge will be passed down to future generations. A student has

already had to push his graduation date back by six months but is struggling to finish their sample making, data collection, and thesis writing. They said, “[I am] trying to cram nine months of in person hands on training into three months of remote training in the lab while trying to write [my] thesis, find a job, and finish sample preparation and measurement.” Knowledge is easily lost in this circumstance. It can take a graduate student years to find the issue that could be mitigated by a quick conversation with a senior graduate student.

Outside of the lab, the COVID-19 pandemic has brought an additional burden to graduate students that we could not have anticipated—each of us is uniquely weighed down by personal relationships to the pandemic. Many students are funded by their department by being a teaching assistant which takes vital time away from your research in normal circumstances, let alone a pandemic where students teaching courses were forced to transition to remote-teaching in the middle of Spring semester. Among the students that I know at CMU, everyone is struggling to teach remotely as effectively as they taught in-person, extending the time away from research. One student in particular has had to do what she approximates is one and a half times the amount of teaching to ensure the students are learning properly. This, in turn, was a great loss of productivity for graduate students in teaching roles. In response to a survey conducted by the CMU Graduate Student Assembly (CMU GSA) in June to understand immediate impacts of COVID-19 and future needs, a student wrote, “I split my time between teaching at a small New York State school and pursuing my dissertation at CMU. COVID-19 has thrown many aspects of my job into question and made it much harder for me to find the time and energy to continue with my research. My advisors have been very understanding but I worry about my ability to complete my dissertation in a timely manner while being so mentally exhausted.” Stories like these are very common.

However, academic issues are not all that students face during this pandemic. Students are using the Carnegie Mellon food pantry at close to twice the rate of utilization pre-pandemic. A study done by the University of Pittsburgh in 2018 found that 29% of all college students in South

Western Pennsylvania were facing moderate to severe food insecurity.¹ The pandemic has made that worse. Moreover, we do not know the scope of this at the national level. At the time, this study was the second largest study ever done on collegiate food insecurity. The full scope of all these issues at Carnegie Mellon was brought to light by the survey conducted by CMU GSA to which close to 400 students responded sharing their personal stories.²

Student parents, on average, experienced some of the most challenging disruptions. It is difficult to be an attentive parent and enroll in coursework, let alone conduct doctoral research at the same time—even with support. The pandemic took all support away in a very short time for many. One student has two children who are less than five years old, another is the father of three. The former is only able to work in the early hours of the morning, making sacrifices of his research for the better of his family. The latter has to balance time between taking care of his children, teaching undergraduate students, and doing research—forcing them to stay up until 3 AM to make any progress on their degree, often relying only on 4 hours of sleep every day. Another student who is a mother of a twenty three month old told GSA, *“In late March, everything changed. Daycares closed, leaving me to choose between trying to figure out how to juggle a full course load while parenting a toddler at least half-time, or find an extra \$10 per hour to pay for a babysitter/nanny. I am an exceptional student. I took additional credits every term until COVID hit and maintained a GPA above 4.0. That semester I dropped down to four courses and found myself part-time childcare (20 hours per week), so that I could try to keep up. In April, my husband was informed that the project he was working on had been postponed until further notice. I was able to finish out the semester strong, but the costs to our family, both financially and psychologically were steep. These difficulties are ongoing. Our daycare plan costs \$400 per month more than it did in our pre-pandemic plan, and I do not know when my husband’s income will return. Furthermore, with rising food prices, our grocery bills have*

¹ Cross, A. B. (January, 2018). *Needs Assessment of Collegiate Food Insecurity in SW Pennsylvania: The Campus Cupboard Study*. University of Pittsburgh.

https://www.pasfaa.org/wp-content/uploads/2019/06/CSF2018_CampusCupboardStudy.pdf

² Carnegie Mellon University Graduate Student Assembly. (2020). *Graduate Student Experience at Carnegie Mellon University During The COVID-19 Pandemic: Findings from the GSA COVID-19 experience survey*

<https://www.cmu.edu/stugov/gsa/External-Advocacy/graduate-student-covid-experience-at-cmu.pdf>

significantly increased. I have looked for cheaper housing options and other alternatives, but the cost of moving alone wipes out any potential savings for several years. I still plan to graduate in May, but I lament the courses I might have taken and the financial stability I had planned/hoped to graduate into. It seems like everything we scrimped and saved for over the last 10 years has been wiped away in a matter of months, and I am afraid to start over with nothing and a young child depending on me.” Having to teach, do research, and take care of the children all day is an extreme amount of work few can do. The need for support is not a novel issue but the ways we need support has changed drastically. We have built communities to tackle such issues in the past, but as we have been forced to go nearly completely remote, those communities do not exist anymore and students are unsure where to go for help.

Students who could not return from Spring break but were otherwise utilizing the university counseling services during their studies were left without access to therapy as many university counselors are licensed in Pennsylvania only. A student from the College of Engineering, for instance, had to replace their counselor with a phone-based mood tracker application. In responses to the GSA’s survey, hundreds of students highlighted their mental health struggles. In fact this is not unique to Carnegie Mellon. In a survey of roughly 4000 U.S.-based STEM Ph.D. students conducted from May to July of this year, 40% reported symptoms consistent with generalized anxiety disorder and 37% with major depressive disorder—jumps of 13 and 19 percentage points, respectively, compared with 2019.³ Another survey conducted in June and July showed similar results: roughly one-third of more than 3000 U.S. graduate students reported suffering moderate to severe depression or anxiety. It’s unconscionable. But this crisis was already in the making, and as a matter of fact, in 2019, the editorial board of the journal *Nature* called for urgent attention to the mental health of Ph.D. researchers after having labeled it a mental health crisis a year ago.⁴

³ Chirikov, I., Soria, K. M, Horgos, B., & Jones-White, D. (2020). *Undergraduate and Graduate Students’ Mental Health During the COVID-19 Pandemic*. UC Berkeley: Center for Studies in Higher Education. <https://escholarship.org/uc/item/80k5d5hw>

⁴ Editorial. (2019). *The mental health of PhD researchers demands urgent attention*. *Nature*. <https://www.nature.com/articles/d41586-019-03489-1>

International students were in an even worse position which was further exacerbated by the July 6th directive issued by the Department of Homeland Security and ICE requiring them to attend classes in-person or leave the country. The sudden shift in policy worsened an already uncertain environment for thousands of Carnegie Mellon students who come from all over the world. While the government rescinded the directive on July 14th, it already had a long lasting impact not just on international students—many of whom were already worried about their families in COVID-19 hotspots—but also domestic students like myself, as was reflected in an Amicus Brief filed by CMU GSA and 15 other graduate student governments with the District Court of Massachusetts.⁵ Already in the middle of minimizing disruptions to research due to the pandemic, students and universities were forced to dedicate their time towards fighting this arbitrary and capricious directive.

Many students struggled with financial issues as well. Monetary struggles are common in graduate school because stipends only allow for a comfortable living situation if you live in the right city. One student from the Mellon College of Science had both of their parents laid off work due to the pandemic. The student is now the sole source of income for their family of six. They are very appreciative of the work that CMU has done to keep the stipend secure and stable but are constantly worried about what lies ahead. To alleviate some issues that can be supported financially, at Carnegie Mellon, the Graduate Student Assembly redirected funds that were initially meant for supporting graduate students to attend conferences and other student activities, into an emergency fund. So far, they have dispersed over \$60,000 to the fund, through which students who are facing financial insecurities during a time when uncertainty looms over their funded research are able to secure emergency grants. Alumni, the Undergraduate Senate and the university administration and staff donated to the fund as well.

Another student has a tragic story that I cannot fully comprehend the effect on a human being. They are from a foreign country where they have not been back to since 2016. Their father and grandmother passed away during the pandemic and the travel restrictions meant they could not

⁵ <https://www.cmu.edu/stugov/gsa/External-Advocacy/gov.uscourts.mad.223165.78.1.pdf>

even attend their funerals. I'm not sure if anyone can comprehend the devastation this student feels. Their life is forever changed and will take a long time to heal. You can tell that issues faced by graduate students are dynamic, covering many aspects of our lives. Things were not the best before this pandemic, they're even worse now. Hence, any plan for addressing the impact of COVID-19 on scientific research could not possibly be complete without actions on these areas by the federal government. This would also empower the universities to better serve their students.

In closing, graduate school is something we do because we want to be here, to learn, work with like minded individuals, and to further our knowledge of the world. In the best of times, the graduate student experience is intense, and we are not currently in the best of times. Students are understandably distressed by changing circumstances and concerns around social isolation, visa statuses, food and housing security, and faculty expectations for research output, along with plenty of general uncertainty about the future. In times like these, we need support more than ever. I hope you continue to hear directly from student researchers on these issues going forward.

Thank you, Ms. Chairwoman.