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Magda Steele lost fieldwork test plots and funding because of pandemic restrictions.

DISRUPTED DOCTORATES

After two years of COVID-related delays, five doctoral candidates share lessons they learnt.

The COVID-19 pandemic has upended working environments and doctoral candidates' schedules. As laboratories closed all over the world, remote working meant that some could read more deeply on their subject area or develop new computational skills. But for others, projects and future research careers were left hanging in the balance.

Some candidates feel they have missed out on the broad experience of doing a PhD. "It's OK to mourn the things that we are missing out on – to attend conferences in person, to do certain kinds of research. But we can't blame ourselves for things outside of our control," says Gwen Chodur, a PhD candidate at the

University of California, Davis.

Many found themselves scrambling for funding to cover the extra time needed to finish their programmes. According to a 2021 report by the independent social-research organization NORC at the University of Chicago, Illinois, two-thirds of the 208 US institutions it surveyed expected to cut their graduate-programme budgets because of the pandemic. But some help might be in sight: government funding to help bridge pandemic delays could soon be available to researchers and PhD students. For example, proposed legislation in the US Congress would grant US\$25 billion to support researchers. And the UK government has allocated more than £60 million (\$81.5 million) to

help PhD students affected by the pandemic.

Here, *Nature* talks to five PhD candidates to find out how they coped with COVID-19 disruptions, by pivoting to different projects, drawing up detailed schedules, adjusting their career expectations and working flat out to make up lost time. Two years after the global pandemic was declared, the lessons learnt still apply to those facing continuing surges in infection rates, or other work disruptions caused by illness, disability or being a carer. The advice could help students looking to refocus when research doesn't go as planned.

MAGDA STEELE TAKE MENTAL- HEALTH CHECKS

In 2018, I started a PhD after leaving the security of a job in horticulture. When the lockdowns began, I was getting my hands dirty in the Store Mosse National Park in Småland, Sweden, measuring changes in the peatlands' carbon dioxide levels. I was knee-deep in nearly one-and-a-half year's worth of fieldwork for my PhD. Travel restrictions and waiting for my vaccinations meant I wasn't able to return to the field for 18 months.

As part of the project, I manipulated the plant community in test plots to include or exclude some plants such as white beak sedge (*Rhynchospora alba*) and common heather (*Calluna vulgaris*). I wanted to know how the different plant combinations change CO₂ absorption and emission in the soil. But as too much time passed, some of the excluded plants grew back and some of my data became obsolete. I lost data from a similar experiment in County Offaly, Ireland, and funding to help pay for some field experiments. A lot of the time and energy I'd put in felt like it had been wasted. It felt like a failure.

My PhD and career were in limbo and I struggled to work from home alone. So, I joined a virtual writing group in which I worked on my dissertation alongside other PhD candidates, all muted on Zoom.

But the continuing pressure and uncertainty pushed my mental health into a nosedive. After I had a panic attack during an online meeting, I decided, in consultation with my supervisors, to suspend my PhD for three months. I took part in cognitive behavioural therapy, to learn techniques to break out of unhelpful thought patterns. It's important that graduate researchers and academics take mental-health breaks like I did and seek support. The longer

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you leave it, the harder it can be to shift negative thinking.

The disruption of the pandemic made me radically rethink my project. I had hoped that my field experiments would lead to several publications, but in consultation with my supervisor, I cut back on the project's scope. In November 2021, I returned to Sweden, where my supervisor had salvaged some of my data. I also travelled to the Netherlands and ran a rough-and-ready lab experiment with another supervisor, in which I grew peat-forming *Sphagnum* mosses in simulated drought conditions and measured how this affects the cycling of greenhouse gases. These data will make up a large chunk of my dissertation.

It's a very small project – the bare minimum to pass – but it was important that I got some hands-on field experience. Students facing major changes to their PhD should evaluate all the available options. Ask yourself what you aim to get out of doctoral training and whether your path will achieve this. Discuss changes with your supervisors, other colleagues and mentors to get an objective view.

Magda Steele is studying ecology at the University of Southampton, UK.

JASMINE EVANS GETTING ORGANIZED AS A COPING STRATEGY

I was a first-year PhD student when lockdowns led to a gruelling remote-learning schedule in April 2020. It felt like we were online from sunup to sundown. In breaks between classes, I had just enough time to stick my head out of the window to gulp a lungful of fresh air and hear the birds sing before ducking back in front of my computer.

I spent a lot of time reading into the background of my chosen area of study – examining whether hesperetin, a compound in citrus fruits, could help to protect against neurodegeneration. I was also given assignments that required more research into the scientific literature than did some assignments from in-person classes, and the deadlines seemed to all come at once.

I developed strategies that helped me through four months of disruption. I moved back to Fitzgerald, Georgia, to stay with my family so I could have supportive people around me. I also created a detailed colour-coded schedule of classes, assignments and deadlines. I plastered the walls of my room with sticky notes to remind me what I had to do and put alerts in my phone as backups.

I really had to take a step back at the end of each day. I made sure to close my computer and unplug. I took time to meditate and quietly reflect on my day. I also started keeping a



KIMBERLY BARBER

Jasmine Evans used a colour-coded schedule to cope with lockdown disruptions.

journal to help process my thoughts.

Once I had a routine, I could appreciate some opportunities that remote learning presented. I really got to grips with my subject area, such as by reading up on the mouse cell line I planned to use in my experiments. The reading also furthered my understanding of hesperetin's potential neuroprotective and anti-inflammatory effects, particularly in neurodegenerative diseases such as Parkinson's and Huntington's. I identified some of the literature gaps, defined my project's focus and designed better experiments.

In addition, I watched YouTube videos to brush up on my experimental techniques, such as culturing cells. I chose videos from reliable sources – those posted by universities, and scientific presentations. All this extra work meant I felt more confident and prepared when I got back into the lab. Now, I'm working through some university breaks to ensure that I graduate on schedule.

Jasmine Evans is studying pharmacology at Florida A&M University in Tallahassee.

ANKIT KUMAR CHOURASIA PREPARE TO HIT THE GROUND RUNNING

I was dreaming of moving abroad, to Germany or Australia, to pursue my PhD, but the pandemic halted my travel plans. Instead, in January last year I began a doctoral programme at home in India, working on a project to build a rechargeable battery that runs on carbon dioxide. Such a battery could provide an energy-storage system on Mars or help to

reduce CO₂ emissions on Earth.

For the first six months of my programme, I had to work from home. During this period, I completed my coursework and read the scientific literature. We typically have a year to complete these activities, but I wanted to finish sooner to free up as much time as possible for experimental work when the lab reopened. This helped me to understand the fundamental aspects of my project and plan how to proceed.

For example, one of the project's biggest challenges is to find a suitable catalyst that will improve battery performance. But I couldn't test catalysts in the lab. Instead, I read computational studies that modelled catalyst surfaces to see how they would react. This helped me to narrow down my list of candidate catalysts and cut the number of experiments I needed to perform.

I expect that future PhD programmes might include a stronger computational component, seeing as how it has benefited research over the pandemic. But I don't see a hybrid model becoming commonplace, because it can only be used in a limited capacity. I prefer a conventional route, which helps to foster a research atmosphere, discussions with group members and implementing your ideas in the lab.

Now that my lab is open, work life is in full-speed mode. We are nervous that our campus will close again, and we will have to stop midway through our experiments. Driven by this, we are working up to 16 hours a day and some weekends. Right now, I am at the limit of what I can do.

The support of my supervisor has been crucial in keeping me motivated. He is sympathetic about how difficult it is to work at this pace, and reassures us that we are moving in the right direction. I'm also keeping

my sights on my future. I plan to look for a postdoctoral position abroad. I have spent my entire education in the Indian system and it's important to me to experience living and working in a different culture. I just hope that COVID doesn't derail this plan, too.

Ankit Kumar Chourasia is studying chemical engineering at the Indian Institute of Technology Hyderabad.

PRACHI RAJPUT A BUMPY LANDING BACK TO THE BENCH

In March 2020, I was shut out of my lab for two-and-a-half months. My project looks at ways to improve the sensitivity of Raman spectroscopy, a technique that uses lasers to analyse the chemical and structural characteristics of molecules to probe, for example, the composition of organic pollutants. Before the lab shut, I was testing whether nanostructures made from metals such as gold, silver or platinum could boost the technique's output signal. But the materials became unstable over the lockdown. When my lab reopened in June 2020, I had to start my experiments from scratch.

I felt disheartened. To pick myself up, I read novels and books on diet and well-being. I also stopped paying as much attention to COVID news because it made me feel depressed. Instead, I completed several small paintings, using watercolour and paint pens. It gave me a sense of fulfilment to complete a piece of work, even if it wasn't related to my PhD. I made slow but steady progress on my PhD through online

meetings with my lab colleagues and supervisor. I also wrote two book chapters.

Whenever infection rates surge, my lab restricts the number of researchers who can enter at one time. This fluctuating lab time made it challenging to manage my work. But I learnt to plan weekly experiments and store the materials at the end of each week in a fridge or under a vacuum, so that they don't spoil. Now, with some data in hand, I can be productive by analysing and writing up results when I have to work from home.

I'm also feeling pressure to find funding to cover fees and living expenses for the rest of my programme. My schedule is tight, and I have less downtime with my colleagues than before the pandemic. If we stop to have tea, we use this time to plan experiments or work in some way. We don't want to waste precious time messing around, because we are one year behind schedule.

Prachi Rajput is studying environmental and chemical sciences at the Central Scientific Instruments Organization in Chandigarh, India.

GWEN CHODUR COMING OUT FIGHTING

When the lockdown hit, I was analysing blood samples from volunteers during the fourth year of my doctoral degree. I was studying changes in genomic regulation that take place during the first couple of hours after eating.

The pandemic kept me away from the bench for almost a year, and then foot surgery

delayed my return for another four months. We were highly limited in our ability to be on campus, and even when I could go into the lab, I couldn't bring study participants into the clinic from off-campus.

My supervisor helped me to think through how I could take my project forward. I decided to analyse data related to my project that were previously collected by other scientists, which I will include in a chapter of my dissertation. I also invested time in refining some of my skills, including in data analysis and visualization. I wanted to be more familiar with R – the programming language for statistical computing and graphics. I used online lessons and workshops such as Data Carpentry and edX. I could go through the online classes at my own pace.

Separately from my dissertation work, I collaborated with another researcher to analyse how access to free food on campus affects the daily fruit and vegetable intake of students who are experiencing food insecurity. This and other work will lead to several publications and boost my job prospects. I was grateful for this pivot because I could be productive even when I couldn't be in the lab.

There is a lot of interest in retaining remote work as an option going forward, to maintain accessibility and flexibility for graduate students and staff with caring responsibilities. But remote work isn't possible for some disciplines – it needs to be an option.

Although I was productive over the lockdown, I don't think the work that I'm doing reflects what I'm capable of. I'm trying to be OK with that. I plan to finish my PhD this year – one year later than anticipated.

I spent a lot of time during the pandemic advocating for graduate students. In 2020, I was elected to the board of directors of the National Association of Graduate-Professional Students, a body that represents postgraduates at US universities, and became its president last year for a one-year term.

Among other battles, I was fighting for graduate students to gain more of a share of the government pandemic-relief funds that universities have received. The hardships of the pandemic add to long-standing struggles that graduate students face regarding workers' rights, including fair pay and paid sick leave.

I made a lot of friends through my advocacy work. We recognize that we aren't dealing with these disruptions on our own. I'm most hopeful that we as a scientific community will really do some soul-searching about how PhD students are treated.

Gwen Chodur is studying nutritional biology at the University of California, Davis.

Interviews by Natasha Gilbert.

Interviews have been edited for length and clarity.



Gwen Chodur became an advocate for the rights of PhD candidates during the pandemic.