Biology lessons in times of COVID

The pandemic has forced educators to teach and instruct online with varying success and challenges

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As Director of the Digital Pedagogy Lab at the University of Colorado in Denver, USA, Michael Sean Morris’ work took on new significance as the COVID-19 pandemic hit campuses around the world. “What happened with the pandemic was a lot of people who weren’t accustomed to teaching online, or dealing with distance learning, or remote learning in any way, shape, or form, really tried to create a live classroom situation on their screen, mostly using Zoom or other similar technologies”, Morris said. “With technology now, we can do things which make us feel closer. So, we can do a Zoom; there can be synchronous chat in technologies like Slack, or discussion forums or what-have-you to make you feel like you’re closer, to make you feel like you’re sort of together at the same time. But the majority of online learning actually has been asynchronous, it’s been everyone coming in when they can and doing their work when they can”.

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Educators have been divided over the use of online learning. But this changed when a deadly pandemic forced everyone from kindergarten to university into digital spaces. Luckily, many digital tools, such as Zoom, Slack, Blackboard Collaborate, or WhatsApp, were available to enable the migration. Nonetheless, teachers, lecturers, and professors struggle to educate their students with knowledge and the hands-on training that is paramount for teaching biology.

Attendance is important

Even if modern technologies have made remote learning easier, it is not the same as physical presence in a classroom. “The expectation is that students will walk away with the same content mastery or skills mastery that they would in the on-ground classroom. The issue there, of course, is if you ask somebody what college is, for example, and what going to college is for, almost no one would say, ‘You go to college so that you learn X, Y, and Z.’”, Morris explained. “Most people would say, ‘You go to college because it’s a transformative experience. You learn who you are, you meet your peers, you figure out what you want to do with the world’.”

However, those objectives are not achieved by online learning. “Online learning is really very instrumentalized, it’s really about getting the content, passing the tests, showing you know what you’re supposed to know, and then you graduate. So, there is a sort of reduction that takes place when people start talking about the objectives of online learning versus the objective of a college-campus learning”, Morris added. “Just about anybody who teaches, at least in college, would recognize that learning continues once students leave the classroom. Students either live in dorms or they have social groups that exist outside of the class, and they’ll keep talking about what’s going on in class. And through that process, they’ll learn”.

This may be even more important for teaching in the natural sciences; Morris noted that as students work in the laboratory in pairs or small groups, learning about cooperation and collaboration, which is not possible to replicate online. “Even if you could create similar learning outcomes where they are doing similar experiments, and they’re figuring out similar solutions, they’re doing it very much all alone. And even if they’re interacting with other students online, it’s still: I’m by myself in my room doing this by myself”, he said.

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An opportunity for public communication

Like most of her colleagues, the pandemic caught Susana Minguet, who teaches Masters and PhD students in immunology at the Albert Ludwig University in Freiburg, Germany, by surprise. “We were not prepared at all. The faculty decided in March to close just 1 week before this big practical with 60 students doing simultaneous experiments. So, it was really a shock for everyone, students and faculty included. Nobody knew what would happen”, she recalled. “Then, the university realized we couldn’t go on like this. We couldn’t put teaching on ice forever. And then they asked us to start teaching online, but nothing was prepared.
Students living close to campus in the Black Forest region of southwestern Germany have access to high-quality bandwidth via the university’s Eduroam system. But they were also competing at home for bandwidth with siblings or parents working remotely. Many students connected on their smartphones, which played well with Zoom. But the university is concerned about security issues involving protection of personal data and recommended using other software, Minguet said. She added that lecturers were instructed to prohibit students from using their cameras: she had to read the chats aloud as students wrote questions. “I don’t like it, but I’m forced to do it like this. We need to record the lectures and upload them in our studies-platform for those who cannot attend live”, she said. The university planned to deploy a new software in January 2021 to integrate Zoom and whiteboard, but it provided just one for students connected on their smartphones, which played well with Zoom. But the university is concerned about security issues involving protection of personal data and recommended using other software, Minguet said. She added that lecturers were instructed to prohibit students from using their cameras: she had to read the chats aloud as students wrote questions. “I don’t like it, but I’m forced to do it like this. We need to record the lectures and upload them in our studies-platform for those who cannot attend live”, she said. The university planned to deploy a new software in January 2021 to integrate Zoom and whiteboard, but it provided just one for testing for the whole biology faculty with more than 1,300 students and nearly 50 professors and lecturers.

The next challenge was to provide the students with hands-on experience in the laboratory. “They cannot finish a Masters in immunology without ever doing an experiment. So far we have managed to postpone this experience and hope that they are going to get it”, Minguet commented. “We hope we can somehow recover this in the next semester. But if this goes longer, we are not going to have time to catch up. They have only four semesters in the masters and two of them are supposed to be fully present in the lab”. Some students have been able to take practical classes—socially distanced and masked—but Minguet and her colleagues had to reduce the number of students per group and repeat the same course until all students had done it (Fig 1). Students needed to work alone, so they missed the social aspects as Morris pointed out.

Minguet also stressed to her students that, as future immunologists, it was important they communicate about the pandemic in everyday language to family and friends. Students in groups of two selected a single subtopic, such as vaccine development or how to protect themselves from coronavirus, and generated Twitter threads with illustrations and words, which she reviewed for accuracy before posting (Fig 2). “Students really liked it. They realized how difficult it is to do science communication and to explain complex concepts in really simple words”, Minguet said. “This is something I would like to use in the future to teach my students how important science communication is and how they have the duty as immunologists to explain it to their relatives and friends”.

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Once the pandemic passes, Minguet hopes this will continue but she also looks forward “to things being stable”, she said. “Right now, we have to plan thinking that the things are going to be better, and we can go back to normal lecturing. In case that this does not work, we have to have a plan B to do hybrid. And in case that this doesn’t work, we need to have a plan C to go fully digital. How many plans do I have to plan? I am looking forward to stability, deciding on a format and keeping it”.

The crucial laboratory experience

When the pandemic hit in March, the Spanish government shut down classes and research at the universities, with the exception of research on SARS-CoV-2. Students for the most part went home. Jose Aramburu, who teaches molecular biology to Masters students and undergraduates in the Department of Experimental and Health Sciences at the Universitat Pompeu Fabra in Barcelona, recalled that he wasn’t teaching during the initial lockdown, so he had time to prepare for migrating online when classes started in April. The university quickly deployed Google Meet, Blackboard Collaborate and Zoom software to enable video communications and collaboration with classes. “Within a few days, students could return to class online”, Aramburu said.

Laboratories were another story. “Our lab was basically closed, with no experiments whatsoever from mid-March, all of April into May”, he said. “We were allowed to take care of the mice, but during the first month we had to sacrifice all the pups”. By mid-May, PhD students and other staff could return to labs provided they kept to a safety plan. However, Masters students did not have access because their authorization, which is also required for insurance coverage, took long to happen. “It seemed as if the Ministry got paralyzed and completely forgot about the Masters students”, Aramburu commented. “These students lost three entire months on their projects”. Most of them submitted their thesis in September rather than the usual time at the end of June and defended it on video.

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Once laboratory work resumed, everything was slowed down because of social distancing. “It was like walking on honey. Everything seemed like it was in slow motion. We wear masks everywhere in our building, even in front of our computers, which makes it hard to understand each other. Masks disrupt the fluidity of conversation”, Aramburu said. “Much of what we did was done with email”. He estimates that the volume of experiments was decreased by 30% which had an effect as hands-on
experience is a more effective means of learning than watching videos. “I think it’s fundamental”, he said. “You need to see it in 3-D and even do it wrong to learn to do it right”.

However, Aramburu also observed from teaching remotely that students “can learn on their own. They are not dependent on somebody just blah-blah-blah-ing. I see that I can drop them some material, or a short PowerPoint with key points, and they’ll learn it. When we come back to normal times, I’ve found that with some of my classes and some of the things I do, it’s not necessary that I have to be there in person. They don’t have to be listening to me all the time”.

**Staying in touch with students**

Biochemist Maria Isabel Dominguez, who teaches biochemistry at Boston University School of Medicine in the USA, already had many resources in place to take her classes online when the pandemic hit. Among other software, she uses Blackboard Learn to post documents, videos and lectures online, and Google to share documents and work collaboratively. “But I don’t think anybody was ready for full remote education. Despite the resources in place, I think the adaptation that had to happen has been tremendous from both the faculty and the students”, she said.

Dominguez said she got a jump start because her Masters class didn’t start until April. “I was told that the students were asked to stay home, and to begin preparing for online learning. The personnel in IT got my computer ready and the one in Education Media taught me how to use Zoom”, she said. “I think it went well overall based on the evaluations that we did of the students”. Yet, Dominguez said that teaching biochemistry over Zoom was a challenge and not just for the fact that students live in different time zones. “In the classroom, you can use your hands and body when explaining the 3D structures of molecules and cellular processes such as migration. But with Zoom, students are looking at something in 2D, so it’s difficult to gauge 3D”, she added.

Dominguez, the former Assistant Dean for Diversity and Inclusion, also directs a summer research program, known as STARS (Summer Training as Research Scholars), funded by the US National Heart, Lung and Blood Institute to support underrepresented students in science and medicine. “We moved the program completely virtually as we did not want these students to miss the opportunity to participate in research”, she said. “I was fortunate that the faculty at BUSM could design virtual projects for the summer, that I had the experience with virtual resources from my class in April, and I had excellent peer-mentors in the program”.

For some of these scholars working from home was challenging owing to technical issues with the internet and phone connections or computers being shared. “You are in your house with limited learning space that you have to share with siblings, which could be distracting. In addition, everybody’s online which limits the functionality of online tools”, Dominguez explained. In response, she and her colleagues increased instruction hours and some students got extra instruction over Zoom from biostatisticians and other professionals.

To compensate for the lack of laboratory work, students were sent kits to conduct experiments at home. Peer mentors—volunteer medical and graduate students—worked with the students on the experiments remotely. The mentors drove social media connections
by asking the STARS students to join a group texting program on phones for mentoring and communications. “These scholars are only here for the summer, so we wanted them to develop a sense of community quickly”, Dominguez said. She added that remote learning “is here to stay with the facility that we have through these new tools like Zoom to interact with the students anywhere outside from the classroom”.

Virtual research projects

When the pandemic hit, Aurora Kerscher, Assistant Professor at Eastern Virginia Medical School in Norfolk, had to punt. Within a week, she moved classes to a virtual platform known as Piazza where students can ask and answer questions. At that point, most of her lectures were over for the semester, but Kerscher still had special topics classes with a Masters student and a first-year rotation student. She was supposed to do wet research but instead switched to a virtual project and bioinformatics analysis of the data. “We had asynchronous meetings where we’d read certain papers, and I would ask them questions”, she said. “Then, we would meet every Thursday night over Zoom for an hour and discuss those different papers as well as more complicated topics. We were talking about metastasis and how small RNAs are regulating that”. For her, the semi-synchronous and asynchronous formats worked well in the emergency.

Kerscher also had to close her laboratory, which posed problems for the rotation student. She punted again. “I had to think of a non-laboratory-based project”, Kerscher said, “I actually picked a topic that we were just starting to work on in the lab but was based on a new field of glycosylated RNAs and their role in cancer, and we both started reading papers about glycosylation of RNAs, and how differential expression of glycoRNAs can be used for diagnostics for cancer, so we were reading up about some of these processes together and refining protocols for the laboratory”.

In June, students returned to the laboratory after a pandemic plan was approved by the school. Still, seminars are held remotely, and all teaching is remote except training in the laboratory. “I can’t wait to get back into the classroom”, Kerscher said. “Genetics is hard to teach online because you need discussion, and you’re drawing out your Punnett squares or working out your genetic crosses”. She added that students are “quieter” on Zoom than in person. “Students want to text versus actually turn on their cameras and turn on their microphones. So, I do feel like it was very difficult. I think it’s more interactive on-site, and I think the students agree with that”, she commented.

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Kerscher, however, now appreciates administrative meetings on Zoom. “I do like that they are virtual because the meetings take up a lot of the faculty’s time”, she said. “Online, things do get done a lot quicker. I kind of appreciate the efficiency of it, and not having to run from one place to another, so it is making me a little bit more productive. This is one thing I hope doesn’t change when the pandemic is over”.

Digital learning as an opportunity

Karen Cangialosi, a biology professor at Keene State College in rural New Hampshire, USA, had been integrating digital tools into her coursework for years, so she and her students were well-prepared while many other educators had to scramble. After classes were shut down in spring, Keene students returned to their dorms in the fall. Under normal circumstances, Cangialosi had 22 students in a class. Last fall, the class size was limited to about 10 with students spaced out six or more feet, always wearing masks. There were HEPA filters in the rooms, which were cleaned before, during and after class.
“I try to encourage my students to build personal learning networks on Twitter, where they find scientists to follow, try to find people that are professionals that are tweeting about actual facts. I do a whole unit on web literacy”, she explained. “You can search Twitter actually and look for articles that actual scientists have been tweeting about and having conversations about. And so, students come to learn how to understand that Twitter can be a really rich place for finding information and having conversations”. Cangialosi added that her course includes a unit on how to evaluate the accuracy of information posted online and introduces her students to a fact-checker course developed by Mike Caulfield, Director of Blended and Networked Learning at Washington State University.

Cangialosi uses Zoom to meet her classes and students individually for discussions or to show online images and videos. But primarily Cangialosi relies on asynchronous methods such as students building their personal websites where they can choose to post content that they are most interested in. Students can also read and comment on others’ work via their web domains.

Not surprisingly, the lab-intensive courses, such as her invertebrate zoology class, are at a disadvantage during a pandemic. “My students were still in the lab looking at some specimens using microscopes and whatnot, but just for many fewer hours than they would have otherwise. The lab was open and available for many hours and students had the option to attend when it worked for them, but I couldn’t always be present and some of my students could not attend the lab at all. I had to be flexible”, Cangialosi said. “What I’ve tried to do is turn my pedagogy toward advancing my students in a context in which they have the challenge of having limited face-to-face time with each other and with me”.

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She added that many technology-averse teachers have been surprised by what online tools can offer their students and emphasized that pedagogical approach and concern for student context and individual situations were far more important than the use of any particular digital tool. “I think that we’ve definitely been changed forever by this pandemic in so many ways. And I think that’s true for higher education in particular”, she said. “I hope that what we’ve learned is that we can be flexible and that we don’t need to rely on companies that make and sell these tools, that we can use many free digital tools and spaces in ways that allow us more freedom and flexibility. We should not expect digital tools to be the answer, instead we should focus on how we center our students in our pedagogical approaches”.

After the pandemic

Morris, whose program at the University of Colorado is called Learning Design In Technology, expects that once the pandemic ends, academics will mostly return to the old ways of teaching, but some may adopt digital approaches that they’ve worked with. He said he has encouraged college teachers to discuss digital strategies, what works and what doesn’t. “It’s important that we do this now. Once we go back, it’s going to be really tempting to have the normal thing happen again”, Morris commented. “Digital learning was around before the pandemic, it will be around after the pandemic. What digital learning will look like in the future may be drastically different because so many people are being exposed to it now that the cracks are showing, and the opportunities are also showing”.

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