

Planning considerations for Socially Distanced Chemistry Laboratories



Dr Cate Cropper,
Dr Helen Vaughan,
Dr Elisabeth Rushworth,
Dr Kathy Johnson,
Mr Steve Chappell.
Central Teaching Laboratories, The University of Liverpool

For correspondence: CCropper@liverpool.ac.uk

This article details the questions and considerations we have raised regarding the return to Chemistry teaching laboratories in September/October 2020. At the time of writing, we are still practicing social distancing to prevent the spread of COVID-19. While some schools have returned and lockdown restrictions are starting to be relaxed, it is important that plans are made to include social distancing measures in Semester 1 of 2020-21 for those aiming to deliver lab course face to face (which I will refer to as wet labs). The response from the DryLabs community, facilitated by Malcolm Stewart, Craig Campbell and Ben Challen at Oxford University, displays a varied landscape of approaches. Initial reaction was that labs may be closed in Semester 1 and at present, the community is working to create a bank of shared virtual resources and communicating openly about their plans. During the DryLabs meeting in May, I questioned whether anyone would be delivering wet labs. The virtual room fell silent! Malcolm suggested I share my thoughts, which I did, and herein follow up on my presentation by detailing those considerations, which I hope will be helpful in shaping your own approaches.

Setting the scene:

Currently, at the University of Liverpool, we know that the beginning of semester 1 will be delayed by two weeks to allow for staggered arrivals to the campus. Students will be issued with facemasks and the University will be providing testing for COVID-19 to all staff and students. We also know that the University plans to take a hybrid approach to their teaching and learning by having a mixture of synchronous face to face interactions (including wet labs) and asynchronous lectures. This information was important to us in planning wet labs because it means that there is more flexibility in the timetable. At Liverpool, we timetable our labs first and then build around them. We work very closely with the timetabling team to ensure optimal usage of the lab spaces.

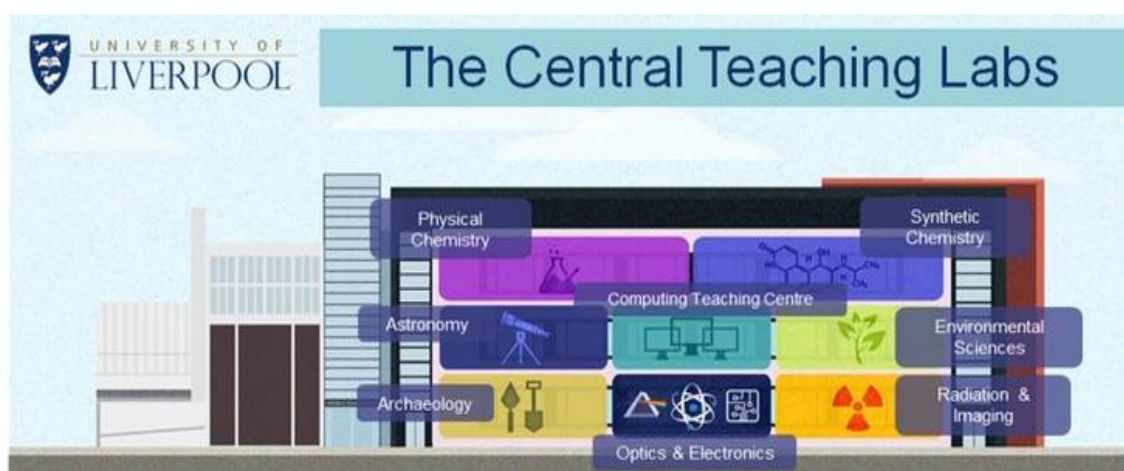


Figure 1: Central Teaching Laboratories at University of Liverpool

Chemistry students at the University of Liverpool complete their practical classes in the pioneering Central Teaching Laboratories (Figure 1). This building contains undergraduate teaching labs for Chemistry, Physics, the Environmental Sciences and Archaeology. Together, all stakeholders have been working to develop plans that are consistent and inclusive.

In the following sections I will explain our thoughts in terms of the flow diagram in Figure 2. The flow diagram shows considerations to be made before students enter the building (orange), while they are in the building (yellow) and when they leave labs (green). The CTL also contains social areas, as many Chemistry departments will do, and assessing the usage of these areas will also be included.

The final section details our considerations for timetabling, technical support and unknowns that will impact on scenario planning.



Figure 2: Flow diagram of considerations for Social Distancing wet lab courses.

Risk Assessments for Building and Labs ([Government Guidance](#) available)

In line with government guidance, the first step is to address risk. While risk assessments will be in place for teaching laboratories, an additional risk assessment will need to be carried out. *“Everyone needs to assess and manage the risks of COVID-19. As an employer, you also have a legal responsibility to protect workers and others from risk to their health and safety. This means you need to think about the risks they face and do everything reasonably practicable to minimise them, recognising you cannot completely eliminate the risk of COVID-19.”* [1]

Risk assessments will need to be carried out collaboratively with facilities management. This will then need to be communicated to staff and students. This could be done via your institutions VLE and/or the departmental website.

In addition, the government have specific guideline on what should be displayed in terms of communicating that the lab has been risk assessed. The signage can be found in the link above.

The government also refer to risk assessments of labs in their document [“Higher Education: Reopening Building and Campuses”](#). Herein, the guidance refers to HE institutions sharing best practice.

What to consider when assessing risk:

- What is already contained in the existing general lab risk assessment. Is this up to date and relevant?
- Do the risk assessments for specific experiments and specific instruments need to be updated?

- You may need to edit the Standard Operating Procedures and therefore the experimental scripts.

For example, if a UV-VIS spectrometer is used in an experiment, what is the risk associated with multiple users? Do you have enough instruments for students to be allocated one each for the duration of the session and can it then be cleaned adequately to prevent contamination to other users? Could the instrument be moved to limit the movement of the user around the lab? Does the SOP need to be amended to include cleaning after use? Does the risk assessment require the user to cover keypads with Clingfilm that can then be disposed of? If the outcome of assessment the risk associated with using this instrument shows that it is not safe to use without potentially causing spread of any infection, can the experiment be altered to eliminate the use of the instrument? How can the learning outcomes still be achieved? Can this be done by providing data from the instrument? Can a virtual experiment be used in replacement? Could the students be asked to design a method of finding something out that replaces practical use of the instrument? Could the students predict what results the instrument would give?

Fire Exits

Part of the Risk Assessment for the Building will include what to do in the event of a fire evacuation. Considerations to be made include:

- Can Fire Exits be used to assist in creating a one-way system within the building or laboratory to aid with social distancing?
- Can Fire Exits be used to increase ventilation within the laboratory?
- In event of a fire, speedy evacuation is critical. Students and staff should be reminded of their nearest fire exit upon entering the lab and told that any one-way systems in place are defunct in event of a fire. Staff and students should be evaluated to an area where social distancing can occur.

First Aid

An increased risk is posed to first aiders. While HE institutions will need to consider this for all settings, first aider in the laboratory will need access to additional PPE.

Air flow/recirculating/ventilation

One of the first questions that was raised by the academic in the CTL was, do we have adequate ventilation and air flow throughout our labs to allow students to be in therefore a prolonged period of time (3 hours or more). This is not a question that can easily be answered without consulting with Facilities Management and may be a consideration that needs to be made for teaching laboratories at other institutions.

Personal Protective Equipment

Chemists are used to wearing appropriate PPE for experiments but further considerations may be needed in relation to additional PPE, its storage and disposal.

For example, in the CTL, chemistry students have their own safety specs and lab coat which they take to and from the lab in a zip-locked plastic bag. All coats and bags are removed and stored in lockers outside the labs. Discussions between CTL stakeholders have centred around best practice in the use of PPE to prevent contamination to other. Should bags and coats be stored in a plastic bag before being put in a locker? Should lockers be allocated to specific students and then cleaned after the student has finished their time in the lab? What would the impact of this be on cleaning staff? Are they equipped to manage this? What additional resources would this require? Should students be responsible for their own lab coat and specs?

Gloves for experiment and for reducing contamination also need to be considered. Guidance should be clear in respect of the use of gloves and their disposal. It may be worth thinking about covering certain objects with a disposable film, allocating equipment to students that is then cleaned properly to avoid contamination. The use of visors and facemasks could also be explored but in our experience this will be an institutional initiative.

Changing Facilities (lockers, coat and bag storage)

As mentioned in the previous section, CTL users store their belongings in lockers before entering the laboratories. This system is common across the sector and usually involves a “changing area”. When discussing these areas, questions arose such as; can social distancing be maintained in these areas? Do we need to stagger the arrival times of students (using a particular lab and across the building), how will we risk assess these areas? While students may be able to socially distance themselves in the lab, can social distancing be maintained at all times in the building?

Entry and one-way systems to the lab bench

The chemistry teaching labs at UoL are in a relatively unique position as they are not located in the chemistry department but a designated teaching laboratory building. This means that access to the chemistry teaching labs can be controlled from the point of entry to the building and egress can be managed without having to consider other people moving around the building randomly. The CTL staff have therefore been able to design a one-way system for all users of the building that need not be deferred from other than to use toilet facilities. Our thoughts involve use of fire stairwells to manage egress and given the multiple stairwell around the building, flow can be managed easily. Pinch point will be addressed by implementing a staggered timetable, which will potentially be implemented across the institution.

Access to toilets and other facilities

While toilet facilities will not be subjected to the one-way system, given the reduced occupancy of the building and large toilet blocks available on each floor, social distancing can be maintained. Considerations may need to be made at other institutions and appropriate signage put in place.

Movement around the lab to static equipment

The manner in which teaching labs operate will vary across institutions but invariably chemistry students will need to access communal waste containers and spectrometers. In order to maintain social distancing, movement around labs should be minimised leading to some careful thought around lab design.

Is it possible to allocate a spectrometer to a specific student?

Can the spectrometer be moved to the student's workspace?

Can individual waste containers be allocated and collected later by a technician?

Can these be moved into the student's work space?

Can balances/chemicals/ all glassware required be moved to student working area?

Depending on the layout of the lab, are screens required to separate work areas?

Cleaning considerations need to be addressed to make equipment safe for frequent use. For example, keyboards. Should students be supplied with their own keyboard or should they be wrapped in cling film? Should/could instruments requiring a keyboard be running as a service?

Where movement cannot be avoided, students should use common sense, just as they would if they needed to access something on a supermarket shelf with another member of the public in their way. Social distancing signage could be used in the lab and floor signage if queues are likely.

Eating facilities and social spaces

Consideration may be given to the social and eating spaces that are in the vicinity of the laboratories if students are likely to make use of them if they are in the lab all day. Areas should be designated and parked out in line with social distancing measures. Students should maintain social distancing measures in the controlled areas.

Teaching considerations and Timetabling

Moving to bubbles of students in week long teaching blocks for labs:

How many students can you fit in the lab considering social distancing measurements?

In order to limit the changeover of students, could a shift to week long blocks of lab sessions for bubbles of students be implemented? Bubbles of students should be kept together for small group tutorials (if happening live), and then bubbles can combine in pairs for lab classes. It is suggested that students taking the same modules and those that live together be put in the same bubble.

What are the pedagogical considerations that need to be made in association with lab blocks? An emphasis may need to be put on pre and post lab activities. How will this affect assessment? Can the learning outcomes still be met? Can accreditation parameters still be met?

Should a certain year group be given priority when designing the timetable and designating lab time?

- Shift minimum possible to "later in year" due to risk of second peak.
- Not all equipment will be available due to the need to clean the equipment (e.g. telescopic eyepieces) consider small amendments to make equipment safe for frequent use.
 - Inform subject areas of equipment that may not be available.

Alternatives:

Have optional summer schools.
Run labs in assessment periods
Late / weekend opening
Staggered start times

Note: Change over and clean down time must be built into the timetable

Impact on technical staff

Is additional technical support required to assist with changeover and cleaning of equipment? What staffing requirements will you have and are these met considering that some staff will be shielding? Can the lab still function with potential illness of staff?

Additional responsibilities might include:

Addition of handwash / sanitisers required and placement around the lab
Cleaning of equipment, benches, door handles etc.
Operating a service for some equipment. E.g. NMR spectrometers

Additional considerations

Advice for safe demonstrating (staff/PhD students/technicians) – Do demonstrators need additional PPE? Should demonstrators wear facemasks where students might be able to remove facemasks while working in their working area?

For remote teaching:

- Are additional licences for software to be accessed remotely? Do these exist in other departments/faculties already?
- Do you need to explore equipment for recording lab activities?
- Add rooms to timetable that can be used to demonstrate use of equipment live or to record use of equipment

Unknowns

- Number of students
- Students may defer
- When and how social distancing will change

The broader landscape

Following the success of DryLabs, Helen Vaughan set up an analogous group for physics; Physics-LTHE. Summaries of their first two meetings are given in figure 3.

Insight Laboratories Meeting

- Blown away by the OU systems
- ...and they offered us access via paid offering
- Scope for Labs@Home using mobile phones
- Recognition that most LOs can be met in alternative ways
- Incentive/Drive to move away from the recipe book
- How do you replicate lab etiquette?
- Technical concerns
- Human Robots!

Summary of Assessment Meeting

- Student written narratives/portfolios used to demonstrate understanding & recognition of learning
- Focus on the LOs/criteria & select appropriate methods – not just exams
- Inclusivity needs to be built in & remember screens/typing are a physical and economic hurdle
- Could it be the return of the oral viva?
- Don't forget e-assessment systems are out there and some are considered good by our community (others less so).

Figure 3: Physics LTHE community meeting summaries

In summary, the approach to how undergraduate chemistry lab courses will be delivered in 2020-21 will be variable across institutions. It will depend on government guidelines, the constraints of the pandemic (social distancing, second spike etc.) and each universities teaching principles. At the University of Liverpool, we will deliver asynchronous lectures with a hybrid of some face to face and some remote teaching. The labs are likely to take a hybridised approach too with some remote experiments and some physical experiments. Lots of ideas have been floated, some of which are captured in figure 4.

Our priorities should be ensuring that labs courses are inclusive, engaging and authentic. This is an opportunity to scrutinise our lab courses, to refresh experiments and develop resources to be used not just now but going forward.

Some considerations – Remote 1

- Human Robot
 - Group of students plan the experiment with a demonstrator
 - Demonstrator then conducts experiment with head/stationary camera and live audio
 - Or access data acquisition software from home
 - Students analyse experimental data and report
- Problems
 - How do you engage everyone?
 - Can someone wear a head cam all day/ 6 hours? Tiring for both sides
 - Provide video of experiments from students to take data from (but when can we make them?)
 - Provide data sets to students
 - Firewall issues (liaise with CSD)

Some considerations – Remote 2

- Lab@Home - mobiles
 - Group of students plan the experiment with a demonstrator
 - Students take measurements using camera, video, microphone or other app
 - Analyse their data and report
- Problems
 - Digital poverty
 - Reluctance to download apps
 - Expense of Apps or Attachments

Some considerations – Remote 3

- Lab in box
 - Send equipment home
 - Arduino, Raspberry Pi & components
 - Synoptic Students to build own detector and then take data to analyse
- Problems
 - Digital poverty
 - Cost
 - Health and Safety
 - Insurance

Figure 4: Considerations for remote teaching from Physics LTHE