



Remote Laboratories: Control Systems Course

Most STEM based courses include practical experimental activities in the laboratory. The aims of practical work broadly encompass the following:

- Cognitive learning which is often elucidated as the integration of theory with practice,
- Inquiry methodology which includes hypothesis forming, experimental design and methodology and evaluation of results,
- Vocational aims which include awareness of current practice and the inculcation of professional ethics,
- The development of personal skills such as communications, report writing and team working skills

Despite COVID, there has been a need to deliver the critical laboratory component of Electrical Engineering coursework, conducted within the physical laboratory¹.

Task

The aim of the Remote Lab Design Team has been to create a learning environment – a remote lab- wherein students have had an opportunity to, through remote access, operate as if in a physical laboratory, thus ensuring opportunity for the achievement of learning outcomes. There have been 200 students enrolled, and working in pairs, 10 lab sessions of 3hrs duration set up per week of Terms 2 2020 for Control System Course ELEC3114.

Action

- There was initial trialling of different platforms; The screen sharing feature of MS Teams and the fact that it was readily available made it the platform of choice;
- The entire Control System Course (ELEC3114) has been set up in Microsoft Teams, including the Remote Laboratory Sessions. Students have been given facility to remotely operate laboratory equipment and conduct experiments with live video feed of equipment in action;
- Lab sessions are run by Lab staff/mentors and while they can be located remotely, they have been located within physical lab space under COVID safe distancing rules. An additional Lab staff member was employed to assist with the remote delivery;
- Microsoft Teams has been used for remote desktop sharing and staff interaction with students;
- New comprehensive general Course Guides have been developed and provided for each subject, including a separate demonstration laboratory work orientation;
- Creation of separate private channels and channels for each scheduled experiment on MS Teams enables students and Lab staff/mentors to communicate, seek help, problem solve, discuss, securely share files, and achieve learning outcomes;
- The Remote Laboratory sessions have been a space in which students can
 - Conduct experiments
 - Realise conceptual understanding through practical application;
 - Practise problem solving, connecting theory to real world problems;
 - Design processes, and work within lab as when in person operations,
 - Manipulate the equipment remotely and observe the results live through video feed (some extra equipment like data acquisition devices and actuators were used to enable remote operation and manipulation);
 - Receive continuous feedback from Lab Demonstrators.

¹ To find out more, contact Arash Kathamianfa. Arash is a member of the Scaling Education Community of Practice (CoP). Click here to find out more about the CoP or contact the EF Team at EF@unsw.edu.au

Success

- The collaboration and delivery of Remote Laboratory innovation was successful and has been applied to 8 other courses in EE&T at 2nd, 3rd, and 4th year level.
- MyExperience results to date (T2 2020) indicate that Remote Labs rating for the Control Systems Course surpassed course, faculty and university mean responses across all criteria with an average of 5.82 (with Median of 6) from 77 respondents (around 40% participation in the survey).
- 100% of respondents agreed with the 'overall satisfaction with the quality of the course': *'The labs were very well executed..... as close as it could've been to the real deal.'*
- Providing time zones are considered when lab sessions are scheduled; remote lab work enable students to participate no matter where they are in the world.

Challenges

- Compressed time frame-3 weeks- to pivot to an online remote solution using existing resources;
 - Use of Microsoft PowerShell to assist with logistics (e.g., to bulk add a group of students into a private channel/lab time slots;
 - Incompatibility of software, e.g., MATLAB with MS Teams meant that Lab Staff needed to be available to resolve issues;
 - Some delay in the way MS Team remote control works (bandwidth issue);
 - Potential workload issues for Lab staff as they are undertaking some of the lab work on behalf of students;
 - Ensuring secure and private access to Remote Labs is work in progress.

Transferability

- To date, T2- Six courses went to using Remote Laboratories; with extra 2 course in T3, giving a total of Eight courses which have been transferred to Remote Laboratory delivery (with some courses in slightly modified formats);
- Limited to existing software and resources; Full realisation of Remote Lab work for other subjects would be with substantial additional investment through, say, use of robotics;
- Process recommended for other science based professional disciplines; Not a replacement of face-to-face laboratory work, but alternative to those who genuinely cannot be present on campus.

Best practice tips, pros/cons

- Assessment becomes integral to delivery methodology, learning objectives, and has been re-considered and redesigned as a result; In this instance, to cover deep knowledge as well as experimental results (practice). And with re-design assessment timelines needed to be modified;
- To minimise social isolation of students, maintain lab staff within physical laboratory with Webcam turned on, and within safe COVID practice guidelines;
- Ensure students working in pairs swap and experience of remote desktop access;
- UNSW IT can create class Teams for you which are automatically linked to enrolment status of students;
- Invest in high resolution webcams, ensure proper laboratory lighting; backup demonstrator computers when there are compatibility problems;

Further information

- Arash Kathamianfar, Lecturer Electrical Engineering and Telecommunications together with EE&T team members Nelson Fu, Zhenyu Liu, Roy Zeng, Dr. Chris Lu and Yen Nee Ho.

References

General Staff Guide to EET Remotely Accessed Labs:

<https://unsw.sharepoint.com/:b:/s/ELEC3114ControlSysDevelopment/EfCQNLp6p3xNu1WtkP1jVoBvLoBP5OIXiiLwlwOYjT6tw?e=hhAcjY>

The website reference for MS PowerShell programming is provided in this guide – comprehensive guide on how to set up communications; (PowerShell is the shell framework developed by Microsoft for administration tasks such as configuration management and automation of repetitive jobs- Please the websites provided for more info).

The role of laboratory work in engineering education: student and staff perceptions, Norrie S.

Edward, International Journal of Electrical Engineering Education

39/1 (accessed <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.915.2121&rep=rep1&type=pdf>)

Reimagining education from the lab to the living room, <https://unsw.sharepoint.com/sites/Education-Focussed/SitePages/Reimagining-education-from-the-lab-to-the-living-room.aspx> 1st July 2020.

Promotional Video of EET Remote Labs

https://unsw-my.sharepoint.com/:v:/g/personal/z3356241_ad_unsw_edu_au/EcMTDadYwGpAvguwlz-HX6kBdsamJGAkuOxi1Bu4Eyexdg

Publication forthcoming about the Remote Lab innovation and implementation planned for 2021.

