

The use of Real Labs Operated At a Distance (ReLOAD) as a teaching aid

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Abstract

Weblabs using Real Labs Operated At a Distance (ReLOAD) were implemented to aid the curriculum delivery in engineering departments at University College London and the University of Leeds.

The flexibility and repeatability of the ReLOAD was shown to be a great asset to both the students and the academic institutions, reducing the timetabling, spatial and financial loads. ReLOAD proved to be an effective teaching aid with 90% of students agreeing or strongly agreeing that “Compared to other ‘hands on’ experiments I’ve done, the ReLOAD experiment was effective in helping to get concepts across”.

1. Background

Laboratory sessions have been widely accepted as an effective method of reinforcing lecture material and are utilised in the majority of engineering departments. However not only is laboratory equipment often costly, but it is also often very difficult to store from a spatial perspective.

A project entitled ReLOAD was developed to allow remote access to real laboratory equipment; this would reduce the financial and spatial load of laboratory sessions on participating universities. In this case the experimental equipment was a position servo mechanism based at the University of Leeds. It was interfaced by a web page with a range of parameters which when selected and submitted instructs the equipment to perform the experiment. Graphs and videos of the results are then submitted back to the student. Tools such as ReLOAD incorporated in weblabs may support the learning requirements of a more diverse student base.

2. Methodology

To analyse the effect of using ReLOAD with students, a weblab was integrated into a third year undergraduate module at University College London (UCL) entitled 'Automatic Control' and a postgraduate module at the University of Leeds.

The module that ReLOAD was integrated into consisted of a single weekly two-hour lecture and two laboratory sessions, one using MatLab and a second incorporating ReLOAD. The ReLOAD lab aimed to develop the understanding of the frequency response technique, teach students to use and manipulate frequency response equations and understand how these frequency response methods represented the dynamic performance of a linear system. The lab was separated into three well-defined parts. The first part was the understanding and manipulation of the frequency response equations. Part two was to use the frequency response to describe the response of a system, where students were given a theoretical system and were required to manipulate and interpret the related figures. The third and final part utilised the ReLOAD system by remotely accessing a position servo mechanism which allowed each student to generate their own data. Students were then required to look in detail at the effect of varying several parameters and then to interpret the results. The weblab was assessed by a written report which was due to be submitted two weeks later.

Access to the lab was by a monitored password system, which allowed the students to participate in the lab for a set period of time and which was terminated once they had submitted their course work. Whilst it is only possible for the lab to operate one experiment at a time, as the experiment is relatively quick and does not require the equipment to be reset prior to the next experiment, waiting times for the students was very short and rarely mentioned by the students in their feedback.

3. Issues

The main issue caused by the use of ReLOAD is the loss of a tangible interaction with the laboratory equipment, meaning that not only would students not learn how to appropriately set up and use the laboratory equipment but they would also not learn what actions they should take if the equipment was not performing as expected.

4. Benefits

The ease of use and reliability of the ReLOAD system was regularly commended by its users, however the flexibility of the system was shown to be its greatest asset, not only from the perspective of the academic institution but also to its students. This was confirmed when the dates and times that students used ReLOAD were monitored and it could be seen that there was extensive use late in the evenings and even on Christmas Day (Read, Hanson and Levesley, 2008).

The weblabs also allowed students who struggled with or were unclear about the original lab to repeat the exercise. This was highlighted by student focus groups that contained comments such as:

Male student 1: It reinforces your learning, gives you a chance to go over it in your own time and in your own home.

Female student 1: I found it more rewarding doing it again at home 'cause when you get it right it is just awesome, I get really geeked out when I get things right on my own without any help from anybody else.

Male student 2: You also get more time to think about the experiment, 'cause when you are in the lab you only get two hours to get everything done so you are doing it and following the lab procedure without thinking what is happening, you are almost doing it without thinking what is happening until afterwards.

5. Evidence of Success

The success of the ReLOAD project was evaluated using a questionnaire and by performing an independent student focus group. Some of the results are shown below.

	Agree Strongly	Agree	Disagree	Disagree Strongly
Navigating and accessing material on the ReLOAD website was straightforward	44%	56%	0%	0%
Compared to other 'hands on' experiments I've done, it was easy to understand the ReLOAD experiment	33%	59%	5%	3%
Analysing the data downloaded was straightforward	46%	51%	0%	3%

I am convinced the data I received is from a real experiment and not just a simulation	28%	72%	0%	0%
Compared to other 'hands on' experiments I've done, the ReLOAD experiment was effective in helping to get concepts across	18%	72%	5%	5%
I would rather do a remote ReLOAD lab than do a traditional 'hands on' laboratory session	26%	49%	18%	8%

Some student comments:

"It is the first time for me to complete a lab on line. It is quite fascinating."

"It is a good and easy way to achieve the same objectives compared to that of working in a traditional lab environment."

"Easy to see what was going on and highlighted the lag of the mechanical output response to the electrical input. I would be happy to use it again."

"It is an interesting idea and more 'fun' than some experiments, however as a one off it is a good idea but it is nice to have a variation of hands on experiments as well as internet based ones for variety."

"Working from home was beneficial, although the fact you can only submit once proved extremely costly as accidentally hitting the enter key would submit your results...as happened to me."

6. How Can Other Academics Reproduce This?

The actual technologies needed to produce this project in-house is now well-documented e.g. Weightman et al. (2007). It has been shown, through the ReLOAD project, that linking these technologies to other institutions both nationally and internationally is realistic. What is now being investigated is how ReLOAD and similar projects can be linked together to allow greater access to the higher education community in general. This has resulted in the formation of a Higher Education Academy Engineering Subject Centre Special Interest Group around the topic of remote access to labs.

7. Reflections

As seen by the results above the feedback from the ReLOAD project was very positive.

One student highlighted that the software interaction of the ReLOAD project may possibly require a minor redesign, to provide a confirmation before submission or to allow multiple submissions should a student accidentally submit results.

In the questionnaire many students commented on the excellent flexibility, ease of use and stability of the ReLOAD system, which was further reinforced by the independent student focus group. This suggests that ReLOAD may offer a large advantage throughout the academic world for teaching labs using equipment that they may not have within their own university or could not realistically timetable for usage.

However, based on the results of the questionnaire and focus group, many students would prefer the ReLOAD system to be implemented in conjunction with 'hands on' labs and not as a replacement. One student however suggested that 'hands on' labs could be "messed up" and the point would be to make it work correctly, as this would really examine the students' understanding of the subject. This highlights the concerns of the students that they were marked on perfect outcomes, yet this did not reflect the unpredictability of real life practical engineering.

8. References

Read, E., Hanson, B. and Levesley, M. C. (2008) Using weblabs as a tool to support a culturally diverse student cohort. *Engineering Education: Journal of the Higher Education Academy Engineering Subject Centre*, 3 (1), 52 – 61.

Weightman, A. P. H., Culmer, P. R., Levesley, M. C. and Hanson, B. (2007) An Application of Remotely Controlled Experiments to Perform Feedforward and Feedback Damping Control of an Electromechanical Servomechanism, *3rd International Conference on Web Information Systems and Technologies (WEBIST)*, Barcelona, Spain, March, 107-111.