WMS and SLS experimental Physiology allied learning scheme (EPALS)

Dr Mark Wall and Dr Dawn Collins

Abstract

Physiology practicals in SLS and WMS were made more interactive by utilising cloud platform technology with recently developed software (Lt, AD instruments). This allowed physiological parameter acquisition within a learning environment. The acquired data and embedded learning material could be accessed off-site and thus used for self-directed learning (SDL). In SLS, questions were used as part of formative assessment for second year examinations. The feedback from SLS and WMS students for this learning approach was very positive and the approach will be utilised in the future. Thus the project was very successful.

Background

The discipline of physiology is a key component part of the biomedical science and medical curriculum and can be defined as "the study of normal function of a living organism and its component parts, including all its chemical and physical processes." In our case, we mostly consider human physiology but the term can be also be applied to simple organisms and even to plants. Physiology can be conceived as a dry and difficult subject, and some of the concepts can be difficult to master from lectures, textbooks and journal articles. Learning and understanding can be markedly improved by including practical sessions, where physiological parameters are measured directly from volunteers. Currently in both Warwick Medical School (WMS) and in the School of Life Sciences (SLS), students in groups of 2-3, make physiological measurements from each other (for example ECG, EMG, nerve conduction, lung function tests etc). The measured parameters are usually analysed in class and then written up as a laboratory report which can be assessed (in SLS). The practical sessions usually run for 2-3 hours.

The aim of this pilot project was to modify the practical physiology teaching at Warwick by making use of recently developed Cloud platform technology. In particular, to make the practicals more interactive and to allow the students to directly compare the "normal" data they acquired with data from patients with pathological conditions. The aim was to acquire physiological data and embed this acquisition into a learning environment. This environment would include diagrams, videos, interactive media, quizzes and assignments. The acquired data and learning material could then be accessed off-site for SDL, revision, assessment etc.

For SLS the acquired data would be analysed at home and then questions would be answered to test understanding and form a small part of a second year exam. The pilot study would concentrate on an ECG workshop.

For WMS, this pilot study covered 2 sessions on ECG and spirometry (lung function) and also extended to lessons on EEG, nerve conduction testing and reflexes.

AD instruments, Powerlabs and Lt Software

The current system used for physiology practical teaching in both SLS and WMS is produced by AD instruments. The system is composed of PowerLab hardware, which is essentially an analog to digital converter, which allows multiple sources of data to be acquired including ECG, pulse, spirometry, EMG, EEG etc (figure 1 and see http://www.adinstruments.com/products/powerlab for more details). The hardware is controlled by dedicated software ran on an associated laptop computer (connected via USB).

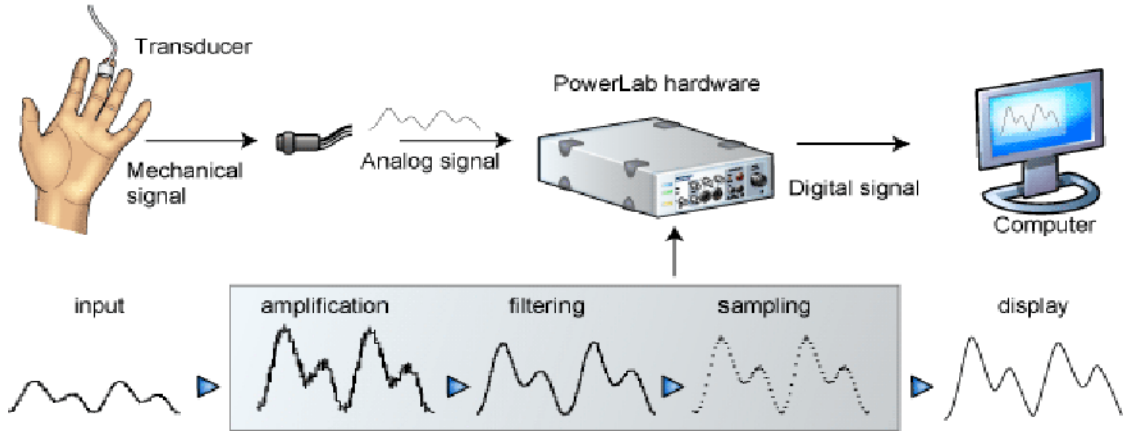


Figure 1. The Powerlab system. Data is acquired as an analog signal (from multiple types of transducer including ECG, pulse transducer etc) into the PowerLab hardware system and then stored and displayed as a digital signal by the associated computer. The signal can be amplified, filtered etc. There are 4 channels so 4 different signals can be acquired simultaneously.

There are currently 20 PowerLab hardware systems and associated laptops within SLS and WMS. Up until now, LabChart software (http://www.adinstruments.com/products/labchart) has been used to acquire and analyse the data. This software package is similar to, but less sophisticated, than acquisition packages used in electrophysiology research, such as Spike and Pclamp. LabChart does not include an embedded teaching environment and is purely devoted to data acquisition and analysis. Using this software, students acquired physiological data, filled in worksheets and then wrote up the practical after the lab sessions had finished.

AD instruments do provide an alternative software package, called LabTutor (http://www.adinstruments.com/products/labtutor) which is designed to enable a more blended approach to teaching physiology. LabTutor incorporates a capacity to include self-taught and interactive elements. However this software package is not readily utilised because of the requirement for dedicated laboratory servers with wired connections to each of the PowerLabs within the teaching laboratory (which do not currently exist).

Recently AD instruments have released Lt (http://www.adinstruments.com/products/lt) an enhanced version of LabTutor, which utilises a cloud-based platform enabling students to personalise their learning experience, combining engaging blended learning material with streamlined methods for data acquisition and analysis as well as incorporating capacity for both formative and summative assessment.

This software has major advantages over LabTutor:

1) It allows physiological data to be acquired and stored on Amazon servers and thus does not require dedicated servers. The data and associated learning material can then be accessed anywhere within in the university and off-site.
2) It utilises Wi Fi technology, which is already present within the teaching laboratories within SLS and thus is ready to be used straight away.

To use the Lt software requires individual licences for each student, so they can access their data and learning material at all times and off site. We purchased ~250 licences at £33 each £8,250. This exceeded our IATL budget but was kindly offset by AD instruments so we could run the study. They also supplied a training session which was not charged.

Advantages of Lt over Moodle

Within SLS and WMS we already utilise the learning platform Moodle for much of our teaching. The major advantage of the LT system over Moodle is the ability to analyse the physiological data the students have acquired. The acquired data for each group of students or for each individual can be accessed on or off campus for analysis. This analysis includes making direct measurements from the data using cursors etc and can be extended for example to directly produce graphs embedded within Lt. Lt also contains many of the components of Moodle and has very good analytics for measuring student performance.

Aims of this project

1) To utilise the Lt software package in SLS and WMS physiology practicals for data acquisition.
2) To embed learning material within the Lt package to strengthen learning and help with understanding and allow formative assessment.
3) To test student understanding by answering questions
4) For SLS: to reduce the lab time to a minimum and shift the analysis from within the laboratory to home. Thus change the practical session from being a laboratory session to a workshop, with the acquisition of data only a minor part of the learning experience
5) Embed feedback questions to determine how the students responded to this teaching method.

Training session

Before the teaching sessions, we hosted a training session run by AD instruments. This ran for one day and covered a number of key components:

- Outlined the flexibility of the Lt package
- Showed how to log onto software and how the students were invited
- How to acquire physiological data within the Lt package and how to analyse it
- How to embed questions and learning material into Lt
- Answered many of our questions on how to run the software and use in practical sessions.

The session was attended by a number of WMS and SLS faculty.

Format of teaching in SLS and WMS using the Lt software package

At home: Preparatory and introductory material.

At home: Preparatory and introductory material,

In the laboratory:
Data acquisition,
analysis, SDL

At home
Access to material
for revision and SDL

In the laboratory: Data acquisition

SLS

WMS

At home:
Data analysis,
MCQs and SDL

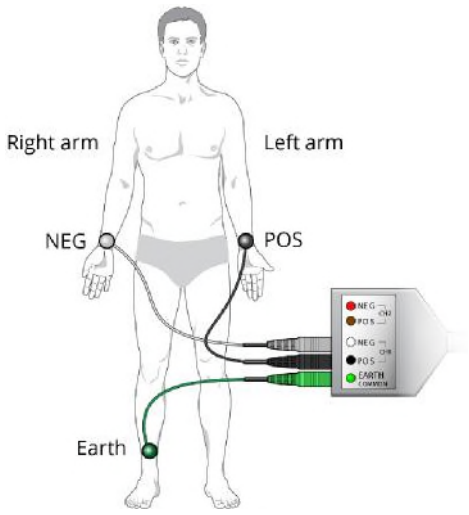
At home:
Access to material
for revision and SDL

Preparation before the practical sessions

Before the students attended the workshops/practical sessions, they had an introduction to Lt software and ECG recording and spirometry in lectures. Students were supplied with SDL material and there were pre-experimental sessions to prepare students for the practical sessions. Students were sent e-mails that invited them to sign up to the Lt Software. They were then able to log on and create a password so they could access the software. This allowed the students to access the recording protocol before the practical sessions, so they could familiarise themselves with the acquisition procedure. This was made clear with messages sent to the students by e-mail, posted on Moodle pages and via announcements in lectures.

ECG data acquisition in SLS

In SLS, two workshop sessions were ran with 3 members of staff. The students worked in pairs. They measured the ECG using 3 bipolar limb leads (see figure 2 for example). The session was attended by 96 % of the students. It took ~10 minutes for each pair of students to acquire the ECG data. For the vast majority of students the session went very smoothly. A small number had not signed up to the software but this was rapidly achieved in the practical session.



To record lead I

Attach the channel 1 positive lead (black) onto the left wrist, channel 1 negative lead (white) on the right wrist. The earth lead (green) will remain in situ on the right leg throughout all recordings to give you the following configuration (above).When you are ready record 15-30 secs of data in the panel below by pushing the **start** button. If the recording is noisy, ensure that the volunteer is relaxed, comfortable, and sitting still. If you still have trouble, make sure that the leads are firmly pushed into the Bio Amp cable.

Figure 2. Recording ECG limb lead 1. Diagram and text explaining how to record ECG from limb lead 1. This is from the LT software used in the workshop

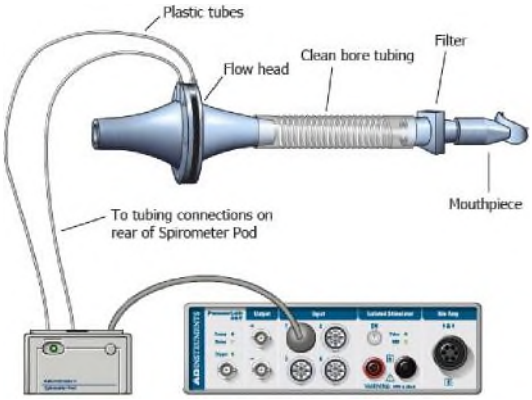
Analysis and learning off-site

SLS students analysed the ECG data they generated in their own time using for example cursors to measure intervals, calculate the heart rate and complete tables etc. There were also questions to answer within this section. These were not for credit but as a learning aid as the answers could be checked against the correct solutions. Once this analysis section was completed there was then access to a second section which tested the students understanding and also contained SDL (particularly focusing on heart axis and arrhythmias). Within this section the students were exposed to real ECG traces from patients with pathologies (some supplied by WMS) and had to identify the underlying cardiac problems.

The students were assessed on the intervals they measured and the answers to the questions in the second section. The overall mark from the workshop provided a small percentage of the Blood and Circulation second year exam score.

<u>The sessions in WMS</u>

In WMS two practical sessions were ran on ECG and spirometry (lung function). The approach taken here was different to SLS in that the lab sessions ran for 2-3 hours and the case studies and data were acquired while the practicals were ran.



1. Connect the Spirometer Pod to Input 1 on the PowerLab.
2. Because the Spirometer Pod is sensitive to temperature and tends to drift during warm-up, turn on the PowerLab for at least 5 minutes before use.
3. To prevent temperature drift due to heating of the Spirometry Pod, place it away from the PowerLab power supply.
4. Connect the two plastic tubes from the Flow Head to the short pipes on the back of the Spirometer Pod.

Figure 3. Section from WMS LT pages illustrating how to set up spirometry for lung function tests.

Below is part of an example case study embedded in the WMS ECG session:

William McGregor, a 67 year old male was admitted to the emergency department following an episode of dyspnoea and syncope that occurred whilst he was working outside on his rabbit farm, digging in fencing which he hoped would prevent the wild rabbits from entering the enclosures. He seemed slightly confused as to why his wife had brought him to the emergency department but when questioned said he felt a 'bit dizzy' and had 'pain in his chest.' His wife told the emergency room doctor that William was diagnosed with hypertension 4 years ago and has been taking verapamil (120mg bd) and metoprolol (100mg od) for this.

On physical examination he was noticeably pale and clammy to the touch. His BP was 138/80 mmHg and his heart rate was 42 bpm. Initially, bloods were taken and an ECG requested. A chest x-ray was considered, but the emergency room doctor decided to wait until the ECG recording had been considered.

What are some of the possible differential diagnoses for his current

condition? *Type your answer here*

The students could put in their answer and then check it against a list of possible underlying pathologies supplied when they clicked a button. Thus the question was to test understanding rather than for assessment.

Specific Problems identified during SLS sessions

1) We (instructors) could not access the ECG traces that the students produced in the workshop. Thus we could not assess the quality of the recordings and whether the measurements of intervals, heart rate etc. were correct.

We could not fully overcome this problem with the practicals that we ran in the pilot study. However we were able to evaluate the ECG intervals and heart rate measurements the students provided against known physiological ranges and thus identify values that were clearly incorrect. After consulting with technical help at AD instruments, we could overcame this problem in the future.

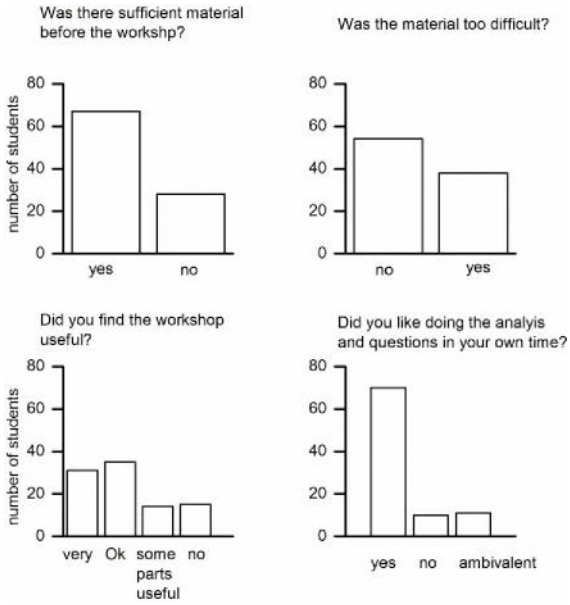
2) One of the tables the students had to fill in was blocked (SLS)

This was our mistake in making the pages (SLS). It was overcome by getting the students to enter the values in the box below. In future the table would be entered as a question

<u>Student feedback (SLS)</u>

Total number of students who responded: 95 (100 % of cohort)

- Were you supplied with sufficient information before the workshop: yes 67, no 28
- Did you find the workshop useful: really useful 31, Ok 35, some parts useful 14, would have preferred lectures 15) (71 % said either really useful or OK)
- Was the material difficulty: about right 54 or too difficult 38 (57 % about right)
- Did you like doing the analysis and questions in your own time: yes 70, no 11, not bothered 10 (74 % yes)



Specific feedback and responses (SLS)

Most of the comments were positive. Here is a selection:

- The questions really helped build my knowledge and confidence in ECG analysis. I think it should be continued.
- I found this form of assignment very useful, especially from an addition learning perspective.
- Loved the fact that I could do the workshop in my own time. You should apply this to every workshop!
- Prefer this style of assignment since it requires you to read things up and there is no time limit.
- This was good in the sense that it makes you think more of the bigger picture, in terms of bringing all of the information together.
- I really loved the workshop, I think it was a really great way to put the knowledge I'd learned to use practically.
- This was more challenging that I expected! But that's probably a good thing! There was a good mix of questions.

Specific criticisms:

- Several students said they needed more background material and needed to cover the concept of heart axis in lectures.

  We provided lots of background material. The idea was not to cover heart axis in lectures but instead make it one of the learning objectives for the workshop. Thus the students were supposed to gain an understanding of heart axis through SDL.

- Some of the students suggested that the questions were difficult and a lot of research was involved.

We tried to make the questions challenging to test the students. However most of the students answered the questions correctly. The idea was that the students would do lots of research and SDL to answer the questions.

- Several students would have preferred bigger ECG traces so that they were easier to read. They found that counting the squares on some of the ECG traces was difficult.

  This is a fault of the software and we are in full agreement with the students. It would be good if you could zoom into areas of the ECG figures on the Lt pages. We will make this clear to AD instruments. We will also increase the size of the ECG traces, where possible in the future.

- Some students found the case studies difficult because they were not shown many real ECG examples in lectures.

  ECG traces are complex!! Usually there are 12 leads and there is a large variation across patients even when there is nothing wrong. Again we were promoting SDL. The idea was to get a flavour of ECG recording and understand the underlying mechanisms. The students are not medical students but need to understand the underlying science behind the ECG.

Specific feedback from WMS sessions

Most of the comments were positive. Here is a selection:

- I found the spirometry and ECG labs very helpful when learning about these areas.
- Lt sessions were very useful, and enjoyable too.
- I really enjoyed the Lt sessions and I think that they are beneficial even if you have studied respiratory function tests and ECG before as the cases force you to think about the tests in different ways, and it is great to familiarise yourself with equipment.
- In particular, I found the guidance about cardiac axis given by Dr Ricky Jones to be fantastic, and ECG basics fell into place for me following that.
- The Lt sessions were helpful and provided a learning opportunity which allowed dedicated contact time with Ricky and Dawn. I also feel I am likely to remember these sessions as they are clinically relevant.
- The Lt sessions were helpful and I appreciated the extra time put in by staff.

Some specific criticisms on WMS sessions

- Some students suggested that there should have been more instructors present at the lab sessions

  Perhaps one more demonstrator could be used next time.

- More explanation in ECG session

  Lots of background material was provided. The idea is that the sessions are SDL and build on lecture material.

- I found the optional labs quite useful, however think they could be improved by having the cases associated with the labs as an activity to complete after the labs.

  We will consider this for future sessions

In the future

It is clear from the feedback that this method of teaching has been a success. It is much more flexible than the methods we used previously. By embedding the data acquired into a learning environment it is possible to: test student understanding by asking questions, compare the data to data from patients, construct graphs etc. It is clear that we will continue using Lt and probably extend it to additional practicals.