PRACTICE-BASED ACTIVITIES:

GUIDANCE AND CASE STUDIES

This document provides advice about developing online alternatives for labs, field trips and studios, along with case studies and practical examples.

RESPONSIVE BLENDED LEARNING 05

INTRODUCTION

Professor Tadhg O'Donovan, **SIG co-ordinator and Associate Head of EPS in Dubai**

For many disciplines, practical (hands-on and location-based) skills and knowledge are a key focus of students' activity. Practice-based learning is also used extensively to demonstrate the practical realization of theoretical phenomena. Science and engineering students learn lab techniques and the ability to design and execute experiments; students in subjects like geoscience and geography spend time in the field; design students create physical artefacts in shared studio spaces.

Where campuses, workshops, laboratories, and studios have reduced capacity and we need to support students who are not able to attend in-person sessions or real-world fieldtrips, new approaches are required. A Special Interest Group (SIG) with representation from all Schools of the University has worked over the summer to develop this document. It contains advice about how to implement Responsive Blended Learning for practice-based activities, along with case-studies to demonstrate innovative ways to complement, replicate or replace current activities. Guidance is provided for three distinct activities: laboratory exercises, fieldtrips and studio-based activities.

The guidance is focused on finding alternative ways of addressing the desired learning outcomes of an activity; including both the explicit learning outcomes – described to students and listed in course documents – and the more implicit learning outcomes that are important but not always overtly stated.

I would like to thank all those who participated in the SIG and contributed to this guidance document; their creativity (and positivity) coupled with a determination to develop innovative approaches to support students across all schools and campuses was inspiring. We hope that this document shows how, through innovation, creativity and technology, many practice-based learning activities can be effectively supported remotely.

CONTENTS

This document follows on from an introduction to **RBL and practice-based learning,** which provided some general considerations and a range of useful links. This guide takes things further by providing more detailed guidance and some practical examples.

FIELDTRIPS GUIDANCE

Fieldtrips are any activity where students are taken or sent to a specific location to view certain features or processes to engage in learning activities related to their courses.

Fieldtrips may be 'show and tell' type or may involve practical activities on the part of the students (such as collecting samples or specimens). They may be focused on collecting observations, measurements or other data for a future project. Trips may involve the whole group staying together, or the group dividing into smaller teams or groups for the undertaking of certain tasks.

All field trips involve an element of risk, as often the locations are industrial sites or remote locations. Students need to be well informed of the nature of the risk that they may encounter and trained to take personal responsibility for their safety and the safety of their colleagues at all times.

TYPES OF LEARNING OUTCOME

The table below lists examples of the learning outcomes typically achieved though fieldtrips. Learning outcomes are listed as *Explicit* if they focus specifically on the intended objective of the fieldtrip; these are normally listed in a Course Descriptor. It is important however to recognise that a laboratory fieldtrip will also develop *Implicit* learning outcomes that are more generally more behavioural and developed over time though experience.

EXPLICIT	IMPLICIT
Identification of features/specimens	Observation skills
Observe a process/activity in the context of the industry	Teamwork skills
Application of theory	Health and Safety procedures
Appreciation of real scale	Logistics and organisational skills
Hands on with equipment	Personal responsibility
Reporting	Effective note taking/recording
Gathering real examples/experience of topics covered in class	Establishing 'corps d'esprit'
Gathering measurements or observational data for later use	Time management
Effective sample/specimen collection and handling	

TOP TIPS

When developing alternative ways of addressing the explicit and implicit learning outcomes associated with your fieldtrip, it may be useful to consider the following

1. Virtual fieldtrips cannot replicate actual field experience. A virtual fieldtrip is a good way to provide a reference resource after the fieldtrip, and some virtual activities can be used as preparation for undertaking fieldwork
2. Virtual fieldtrips can be used as preparation and reference activities in future teaching. Virtual field activities are a 'reasonable adjustment' for inability to access a real field site. Such materials will be of value to support students with additional needs where necessary.
3. Structure virtual materials in such a way that it is modular: keeping introductory material separate from (but compatible with) virtual materials intended to stand-in for real field activities will make it easier to use the former as a prequel to real field work
4. Fieldtrips are highly visual; alternatives need to reflect this (videos/photos)
5. Virtual fieldtrips can allow students to be exposed to a wider range of locations
6. Virtual fieldtrips can be in a variety of formats depending on the learning outcomes that need to be addressed by the fieldtrip, e.g. picture galleries, modelling exercises, activities.
7. Maintaining student groups to perform virtual tasks is important to underpin many of the learning outcomes
8. Students who are not 'on-campus' and cannot attend a physical fieldtrip could be included in a physical fieldtrip by teacher broadcast from the field, or by 'buddying' systems linking students on the trip with those unable to attend. This may not be possible for fieldwork in remote locations without good connection and alternative locations may need to be considered.
9. Students must not be directed to do fieldwork on their own, due to Health and Safety considerations. If fieldwork is suggested students must be carefully guided in safety and risk assessment. It may be possible to provide links to publicly available sites (e.g. the Geological Society of Edinburgh has a number of 'fieldtrips' with leaflets advertised) as an alternative to normal field trip localities.
10. Site visits or visits to companies could be replaced with a virtual tour and a Q&A session with someone onsite.

EXAMPLES

Case-study examples are provided here to demonstrate how the learning outcomes normally achieved by conventional fieldtrips can be attained remotely, within the limitations of physical distancing and by making use of technology.

1. **Inverness Fieldtrip (Helen Lever)**
   Use of existing photos and videos of the field locations to provide appropriate imagery for students to see rock units and details of texture/structure for use in their projects. This project also uses GoogleEarth projects to provide location information and additional images, and to see broad features that are often not clearly visible from the field locations.
2. **IGE Efficient Frontier (Mark Bentley)**
   A combination of uploaded 'quickie' videos and photos from the field, in field tutorials with the students (only possible due to 4G availability), online exercises developed for students to work through decision process.
3. **IGE CPD Graduate Onboarding (Mark Bentley)**
   A live event using a combination of small groupwork, live sessions, exercises and three 'fieldtrips' which were replaced with visual materials of different sorts. Not strictly a virtual field trip, but an example of a live virtual course being run for a group of students who would otherwise have been on campus.

1 Virtual Fieldtrip to Inverness (Geology)

Dr Helen Lever, **EGIS**

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Revisit learning from course in advance of Group Project
Depositional environments, shapes and correlation of reservoir rock units
Internal porosity and permeability distributions
The effect of structural deformation on reservoir properties
Comparison of real rocks to core plug data
Safety considerations while in the field, collaborative thinking on safety
Teamwork, timekeeping and personal responsibility

DESCRIPTION OF ACTIVITY

The physical fieldtrip visits 5 separate localities in the Moray Firth, each with a different depositional environment, so that at each location we can discuss the correlation and distribution of rock units in a specific depositional environment, as well as (at some localities) structural features and their effect on the rock mass.

Fieldwork like this is very visual, so that the main resource of a virtual fieldtrip must be images and videos of the rock locations. At each locality, there are various features that the instructor would draw to the attention of the students while in the field, and these have been separated out in the virtual version into separate folders to help the students see all the important features present.

All the images and videos are posted in VISION, in separate folders for each locality and then separate items for each detail.

A GoogleEarth project provides geographic locations and some images associated with each locality.

For each location, a short test is created on the location to track the progress of students through the available materials.

General references are provided as well as specific papers for each location, and in some cases we are able to link to 3D models provided by outside parties.

Two live 'webinars' were run during the week the physical fieldtrip would have happened, which aimed to take the students through the material and briefly cover or point out the important 'take-home' lessons for each outcrop. These were recorded and posted in the virtual fieldtrip area.

TECHNICAL GUIDANCE

This example uses VISION to disseminate the material, so no additional technical guidance is required. Items are subdivided by topic, location and then details for observation, in addition tests are located in each location folder. Other exercises could be included on specific aspects, if the learning outcomes require!

RATIONALE

How does the activity address the learning outcomes?

For this particular example, the main learning outcomes were about revisiting depositional environments as taught as part of the course (G11PG), specifically in context of real North Sea rock formations. Therefore viewing these formations was important, as was the consequent discussion about the likely extent of reservoir rock bodies and the properties of these bodies within the subsurface. The outcrops each represent a different environment of deposition (or structural feature), so each is documented in the virtual version with detailed photographs and videos, including specific details that would have been pointed out to students while in the field.

Therefore the materials, although not as 'real' as actually visiting the localities live, provide the students with the background information to do their group project where they need to interpret a set of rock data in terms of depositional environments and correlate their wells, and also to use their core measurement data effectively.

Strengths

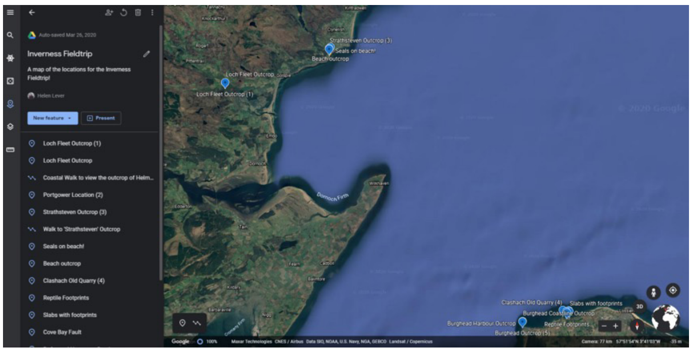
- The material is comprehensive and all students have the same opportunity to see the details documented here.
- The material is available after the 'fieldtrip' period, for reference and for use in projects.
- During physical fieldwork students may be distracted by adverse weather, other students, discomfort, or may become overtired or drink too much thus limiting their attention to the fieldwork – physical discomforts are much reduced by virtual events, although distraction is still a possibility.

Limitations

- Virtual versions of fieldwork do not provide the same tactile experience of rocks as a real fieldtrip does. Research shows that memory retention from virtual experiences is lower due to this lack of physical memory linkages.
- Students may not engage with online activities as readily or completely as they would if they were physically attending a fieldtrip.
- The ability to ask questions and engage in the teaching directly with the lecturer is perhaps more limited in a virtual setting – students may (or may not) feel differently about asking questions during webinars, either finding it easier or harder.

Resources used:

As well as VISION, we have used GoogleEarth to provide a geopgraphical picture of where the outcrops are located. A GoogleEarth project allows the association of pictures with an outcrop location, so that some of the images can be included here.



2 The Efficient Frontier; a field-based event in Pembrokeshire

Dr Mark Bentley, **EGIS**

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Appreciate what reservoirs really look like by examining outcrops from analogue geology exposed at the surface
Be able to place the outcrops in a mature field producing setting, including an understanding of the reservoir setting, the fluid content, the well stock and the facilities and processing infrastructure
Consider late life options for these assets
Determine the $ value of opportunities in these mature fields
Comparison of real rocks to core plug data
Place an uncertainty on the valuation
Place a risk on that value
Determine the position of each asset on the Efficient Frontier and make a decision on what to do next with the portfolio

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

- **Any energy-related groups**
- **PGT initially but can be pitched at any level**

DESCRIPTION OF ACTIVITY

A four day online event using RBL: a combination of online talks, online coaching, interactive discussion, video content from the outcrop, including live streaming, and online feedback from students, ideally working in teams.

The geology outcrops around the Pembrokeshire coast are treated as surface outcrop analogues for underground reservoirs, to which data sets are attached from real producing oil and gas fields, or reservoirs being used for storage of CO2 or energy.

Each reservoir is place din a subsurface position, filled with fluids and treated as a real fluid resource. The engineering aspects associated with managing these reservoir assets, and the commercial value of each asset are evaluated in the context of their true setting in Wales, connected to the Milford Haven infrastructure.

The event is focussed on decision making for subsurface assets ("is it worth using them?") but touches on issues of environment and energy provision.

The course can be run for oil and gas assets, post-carbon development (hydrogen and CO2 storage) or a blend (energy transition).

TECHNICAL GUIDANCE

The field videos were made cheaply and quickly on an iPhone – this meant they had to be short, typically 2 minutes, as download to a laptop was time-consuming and long downloads tended to time-out. These can be stitched together if you have handy editing software on a phone or laptop. (I didn't, so uploaded to Vision separately).

Taking videos much improved if you have: (a) another person to hold the phone and film, or (b) a gimble mount for the phone on a selfie stick – I bought one online for ca. £50.

For live-streaming, don't rely on it as it comes and goes (!) – worked from the outcrop as a tutorial which in the case was from some rock outcrops on a beach in Tenby. Only worked because there is 4G throughout most of the town. Benefited from a test before-hand to check 4G was available below the cliff line and outcrops were selected which had signal. Wasn't the best location unfortunately, so still shots from the prime localities were taken and embedded in the teaching material.

RATIONALE

How does the activity address the learning outcomes?
The learning outcomes are based on seeing real reservoirs at surface and the characterisation of those outcrops. The key is to apply the engineering and commercial theory to a real place, hence the selection of Pembrokeshire as a location on which to base the event (this can be transported to other locations with reservoir analogues at the surface).

This does translate online, and although not a first choice all learning outcomes listed here COULD be met.

Strengths

- Real world framing
- World class examples
- Real industry data mapped on to the outcrops
- Inspirational location
- Core learning objectives CAN be met delivering this online, and this is aided by good will from students who appreciated the energy and effort going into the exercise

Limitations

- Self-evident, perhaps, but students need good wifi
- Tutor needs good broadband to maintain connection – ideally fibre.
- At the end of the day the whole thing is best done live on the outcrops ('hands on rocks') so online is definitely second best.

3 IGE CPD GRADUATE ONBOARDING

Dr Mark Bentley, **EGIS**

Exploration and Production Foundation Course – multi-team-based onboarding event
Ten days, 80 hours, 24 online students and 4 tutors

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Be able to describe how the exploration and production business works in practice
Describe the linkage between E&P disciplines, from geoscience through subsurface and surface engineering to commercial evaluation
Describe what is meant by a technical and commercial 'integrated team'
Describe the field life cycle and place company assets on that cycle
Describe the meaning of 'value' in the context of an energy company
Summarise using a real world case study how this works in practice
Explain how this is achieved using team-based working

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

Early career continuous professional development (CPD) Delivered as CPD to new graduate intake in an energy company, but can be easily re-shaped and re-pitched for PGT or UG (a stripped-down version of this will be used as the PGT introduction week in IGE in Sept 2020).

DESCRIPTION OF ACTIVITY

Participants are given a high-level overview of the energy business and practice their understanding by making development planning decisions on industry case material – in this case an oil field in Oman.

In practice this involved delivery of 17 talks and team-based working on 15 linked case exercises. The teaching was led by 2 tutors working hand-in-hand, supported by two company staff who helped coach.

The event ran over two weeks and if run live it would have including three field visits: one to a geology rock outcrop, one to an exhibition centre to look at industry equipment and one to a live engineering plant. These were not run and were not replaced directly, although comparable visual material was included in slide packs and video clips (open-source corporate video clips).

The real challenge was the team working as this is fundamentally designed as a team-based activity with multiple teams working autonomously and feeding back in forum. Final presentations are made by each team to a 'management board' in forum where the teams make a budget request for development activities on the oil field asset, based on the results of their 15 tasks.

Days ran on a 'standard' training day timetable in Oman – start at 7am, close at 4pm. Because of the UK/Oman time difference, the days were designed with two hours team-based working on the case, with Europe-based tutors joining for the remaining 7 hours, starting at 6am and closing at 1pm. Sessions were broken to limit 'talk' time to around 45 minutes and talks were made interactive as much as possible – NOT straight lectures. Most conversation happened in the chat and tutors developed a habit of breaking their presentations to respond to chat questions. Once students realised this was happening, they engaged more in the chat and it became interactive.

Students were encouraged to walk around, stretch and get away from screens in between talk sessions.

Around 70% of the event was conducted in 'team rooms' with smaller groups (6 or 7 people in each). Talks and tasks were interwoven to create variety and teams were left to organise their own time within their 'tasks'. Overall timings were fixed, however, and team rooms were open and closed on a schedule. The set up on Webex was therefore one main room, where all the talks were delivered and feedback shared, and four team rooms. For coaching, the four staff rotated around the team rooms as they would around breakout rooms in a traditional setting.

The two week event will repeat for a second group in August. A tutor guide was written by the lead tutors to assist the 'walk-in' company tutors and coaches.

TECHNICAL GUIDANCE

This event was written from scratch over two months by the two tutors in May and June and was to run live in Oman in July over two weeks. In May the decision was made to re-shape for online delivery because of lock-down restrictions.

The event ran live online in July – one tutor working from Wales, the other from Portugal and with the participants all at home in Muscat with one company ‘anchor man’ in the company office in Muscat, where IT support was available. This was run on the company’s preferred software platform, which was Webex (comparable to Blackboard Ultra) with file-serving done on the company’s internal learning hub (comparable to Vision).

All material was uploaded prior to the event and reshaped into a ‘reference set’ for the students to refer to, and a ‘presentation set’ which was held by the tutors and delivered remotely. The presentation set included case study solutions and some Q&A exercises and pop quizzes. The presentation set also differed as it included recaps, PowerPoint animations and some progressive ‘reveal’ slides (to limit the amount of text on any one screen).

One tutor had fibre broadband and the other initially standard ‘copper wire’, upgraded to fibre during the event. Once on fibre, the system uptime over the two weeks was 100%.

During live delivery the four tutors found it useful to keep in touch using a WhatsApp group so conversations/observations could be shared without the participants listening in. Enabled real-time course changes if the view was that adjustments were necessary.

RATIONALE

How does the activity address the learning outcomes?

This was the most ambitious online conversation we’ve done as the general view was that it was ‘not possible’ online as these type of multi-team events are interactive and usually fairly high energy.

In practice, the learning outcomes were met (one proviso) and the event finished on a ‘high’, delivering with energy to the management board and with a presentation quality comparable to similar face-to-face CPD events. The chat was emotional.

The proviso is that it was not possible to be sure all participants were engaged. In a live event over two weeks, everyone can be talked to and coached individually at some point and any learning issues/problems identified on the fly. In the second run in August, the tutors plan to record interactions with the participants (just a check-list) to ensure everyone is communicated with directly at some point.

Strengths

- Interactive multi-team working can be achieved if system uptime is good and tutors have good fibre connections
- Learning objectives can be achieved as hoped
- Field components were not missed (what you don’t know, you don’t miss)
- The event was fun
- Will be much easier second time

Limitations

- Fun, but required MUCH more energy from the tutors to deliver this and communicate enthusiasm through a screen
- Possibility of ‘losing’ one or two participants is higher online
- Fundamentally these events are better live as the interaction is more natural and it’s easier to maintain energy in the group, so this is a COVID work-around

LABS GUIDANCE

Laboratory exercises (labs) are a form of hands-on practical work normally involving use equipment that can be controlled to yield repeatable results; this might include exercises where students have to develop a project from a kit, or test the performance components. Labs are often used to demonstrate theory or to investigate the practical application of theory. For *dry labs*, fluids might be included as part of the working rig, however, students are neither in contact with these fluids nor required to handle them. Dry labs do not require COSHH (Control of Substances Hazardous to Health) assessment. For a *wet lab* – commonly used in biology, chemistry, and chemical engineering – students will be handling liquids and other chemicals that require a COSHH assessment.

Labs often require access to highly specialised equipment, in a controlled environment with enhanced Health & Safety practices. It is also normal for students to work in small groups with their peers. Offering a lab experience and reaching the desired learning outcomes remotely pose some significant challenges; this document will offer guidance on supporting students to reach the desired learning outcome associated with laboratory exercises.

TYPES OF LEARNING OUTCOME

The table below lists examples of the learning outcomes typically achieved though laboratory exercises. Learning outcomes are listed as *Explicit* if they focus specifically on the intended objective of the laboratory exercise; these are normally listed in a Course Descriptor. It is important however to recognise that a laboratory exercise will also develop *Implicit* learning outcomes that are more generally more behavioural and developed over time though experience.

EXPLICIT	IMPLICIT
Establishing relationship between theory and practice	Troubleshooting
Training in use of equipment	Experiment planning
Communicate complex ideas and information via laboratory notebooks and factual reports	Gaining experience of lab environment
Understand the importance of physical units of measurement	Following of standards
Critical analysis of experimental data	Health and Safety practices
Calculation of experimental error and uncertainty analysis	Dealing with uncertainty
Reporting	Learning through failure
	Teamwork skills
	Time-management skills
	Organisation skills

TOP TIPS

When developing alternative ways of addressing the explicit and implicit learning outcomes associated with your laboratory exercise, it may be useful to consider the following

1. Assessing more regularly throughout the experience, not just at the end
2. Maintaining a level of inquiry; students to seek out the data and operation of the experiment
3. Developing a 'pre-lab' exercise for the student to minimises the time required in the lab.
4. The risks involved in any activity student are being asked to do on their own, outside the lab, or at home.
5. Group work activities, to address some of the implicit learning outcomes of traditional laboratory exercises.
6. Whole-class (or larger groups) engagement via chat/discussion boards about certain experiments; this could eventually lead to a set of FAQs for other students.
7. Encouraging student engagement and enquiry; the laboratory experience should expect students to seek-out the information/data they need.
8. Allowing students to 'learn through failure', providing formative feedback and encouraging iterations of the laboratory exercise.

EXAMPLES

The learning outcomes normally achieved by conventional labs can be attained in a number of different ways. The case studies included illustrate how some of these methods can work in practice.

1. **Simulation Environments:** The use of software tools to allow students to simulate the experiment. This is also a solution that might complement the traditional laboratory experience by preparing student in advanced a scheduled practical lab.
2. **Recorded Videos:** Using existing or new recordings of the existing experiments; this approach should include additional features, such as built-in quizzes to encourage engagement and offer additional material resources.
3. **Remote Operation:** Students remotely access and operate the experiment setup. This is suitable for experiments that normally use a software tool to operate and control the experimental equipment/hardware and without the need to alter the hardware setup physically.
4. **Remote Operation (by staff):** A member of staff would conduct the experiment and live-stream the process to a group of students. This will allow physical alteration to the equipment which could be based on student feedback, guidance, and requests.
5. **Laboratory 'Take- Home' Kits:** Purpose-specific kits to be provided to students to support laboratory or design exercises to be conducted from home.
6. **At Home Labs:** Experiments that use household items; this will give students an opportunity to learn independently, develop their creativity and hopefully have some fun.

1 TAKE HOME KITS: Introduction electronics; the 'Little Red Box'

Dr Bill MacPherson, **EPS**

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Training in use of equipment
Assembling and understanding practical circuits
Analysis of experimental data
Practical investigations and problem solving
Health and Safety

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

This case study has been used for year 2 electronics courses for Physics students. Many of the concepts would be adaptable to other subject areas (early years of Engineering Courses; Programming, Electronic Design etc)

The concept is suitable for all student levels, but it is common that more advanced components and equipment are needed for later years, and cost implications may constrain deployment in such cases.

DESCRIPTION OF ACTIVITY

The 'red box' contains several electronic components, batteries, connecting leads, and a low cost multimeter. These components are sufficient to allow students to complete a number of practical tasks that are aligned with the lecture material. Some of these activities contribute towards coursework submissions, via Vision.

The emphasis is on learning – therefore peer-to-peer support is encouraged but must be acknowledged in any coursework. There is good evidence that students learn well from doing practical work and learn a lot from discussing this with their peers – therefore peer support is a useful means to help them develop their understanding.

TECHNICAL GUIDANCE

Hints and tips developed over several years of using this 'red box':

- Although an extra cost, **a robust storage box** is a good long-term investment. If you plan to reuse the kit, then it keeps things together and prevents damage.
- Include label with **detailed contents list**. Include supplier details and part number so students can look up component information direct from suppliers. It also helps with checking kits are complete, and a convenient reminder of replacement part details.
- Have an **introduction session** to cover H&S, basic operation of equipment, and how to identify components. Early year students may be in a situation that although they have seen the theory, they might never have seen actual items. Going forward this might take the form of a video podcast.
- Embed the activities into the course. In this case study some of the coursework requires the students to use their kits. For example:
  - Set up prescribed circuits and provide photo evidence (including student ID card) uploaded to vision. Here the assessment is simply have they managed to complete the task and explain what is going on. i.e. light touch assessment.
  - Use the kit to demonstrate a theory covered in lecture course. Written submission via Vision to include photo evidence.
  - Use kit to complete lecture material / course notes. i.e. allow students to self-learn from experiment.
- Keep it simple. If it does not work reliably then that can demotivate the student and/or confuse them. In this case study support was easily offered via end-of-lecture conversations. An alternative approach (discussion board/room or scheduled drop-in session) may be necessary in the coming year.

RATIONALE

How does the activity address the learning outcomes?

The supported activities develop the learner's skills and knowledge in a number of ways:

- Develop skills in simple circuit construction and testing via setting up and troubleshooting
- Provides practical data / observations that can be compared with theory
- Improves their confidence in trying things out

Strengths

- Flexibility: Can be worked on at home, at the student's own pace, and at a time that suits them.
- Potential to be open-ended: although there is a structure to follow, some activities could be designed to be more open ended. There is anecdotal evidence that this experience has encouraged students to continue exploring this topic as a hobby.
- Supports different learning styles: it is accessible to students who benefit from working in a group, but is equally accessible to lone working.

Limitations

- Requires planning in terms of providing the kit and thinking through all activities in advance.
- Not possible to do more advanced experiments (that might use more advanced/expensive test equipment)
- Assessment using this must consider that peer interactions are likely, i.e. groupwork rather than rigorous individual assessment.

2 TAKE HOME KITS: Arduino Robot Design

Dr Keith Brown, **EPS**

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Analysis of experimental data
Training in use of equipment
Understand the importance of physical units of measurement
Troubleshooting
Planning of experiment
Experience
Behavioural
Following of standards
Health and Safety practices
Dealing with uncertainty
Use a range of numerical and graphical skills

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

Basic Robotics, Sensor Characterisation, Experimental Design, Electronics

Most suited to year 1 or 2 students but could be used for other later years

DESCRIPTION OF ACTIVITY

A kit including a programmable robot, microcontroller for building digital devices (Arduino), electronic sensors, prototyping board and connecting wires is provided to students. For health and safety reasons in the home, sensors will be made available as pre-soldered kits so there is no requirement for soldering away from the lab.

A set of activities, with supporting short videos are made available to help the students keep track of their progress on the course. Online help sessions are made available to replace the in-lab help sessions. Students will be able to upload their systems design, programming code and a short video demonstration for assessment.

Activities may include:

- Setting up and characterisation of sensors
- Programming of a robotic vehicle
- Developing a ‘light-following’ vehicle
- Developing a ‘line-following’ vehicle
- Extending the vehicle’s capabilities/feedback and control by incorporating additional sensors
- Extending the vehicle with bodywork or other features (open ended design)
- Writing of a lab report on the sensor characterisation
- Writing of a group report detailing all achievements during the project
- Test day demonstration of achievements and review of other student’s project work

TECHNICAL GUIDANCE

The kit includes:

- Arduino UNO R3
- Ardunio Case
- Breadboard 400 points
- Assorted Jumper wires
- 9V battery
- 9V battery Snap
- Arduino Sensor Shield - V5
- L298 Motor driver module
- Optocoupler encoder module
- Line following sensor
- 9g Micro Servo
- Ultrasonic Sensor
- Acrylic robot chassis with wheels

RATIONALE

How does the activity address the learning outcomes?

It allows most of the things that go on in the lab to be experienced by the student (there will be no access to soldering, 3D printing or laser cutting).

The students will still be able to achieve all of the learning outcomes for this 100% practical course.

Students can get data from the sensors for analysis and further interpretation as in the lab.

The students will gain experience of the issues of practical work.

Strengths

- Most aspects of the lab based work are covered.
- It allows the students to still undertake real practical work.
- Experimentation and troubleshooting are still central

Limitations

- Won’t have access to soldering, 3D printing and laser cutting
- Won’t be working as part of a group and getting the peer to peer learning benefits associated with this.
- Online help will be harder to facilitate with this sort of practical work.

3 RECORDED VIDEOS: Labs with Embedded Quizzes and additional Visualisation

Mohamed AL Musleh, **EPS**

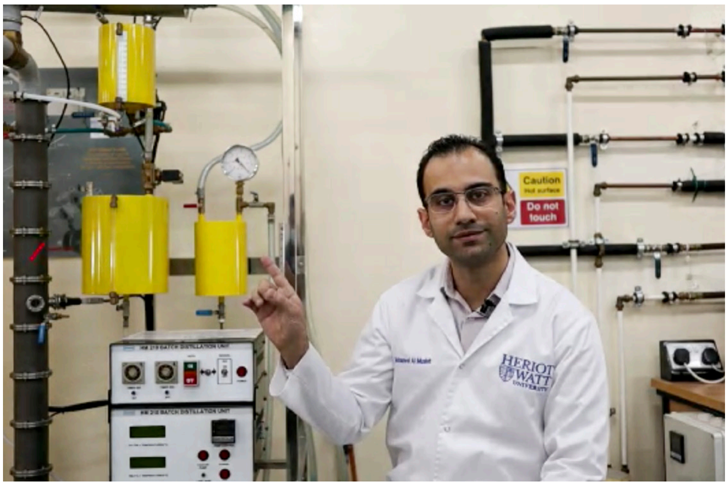
EXPLICIT AND IMPLICIT LEARNING OUTCOMES	
Analysis of experimental data	**Following of standards**
Training in use of equipment	**Dealing with uncertainty**
Understand the importance of physical units of measurement	**Learning through failure**
Planning of experiment	**Use a range of numerical and graphical skills**
Experience	

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

Science and Engineering **UG**

DESCRIPTION OF ACTIVITY

A demonstration of the laboratory exercise is pre-recorded; the recording is then edited to include quizzes inserted at key frames to test the student's knowledge and support engagement. Student answers are used to determine what they see next or to release relevant support material and specific experimental data. These videos and the associated quizzes can be integrated within Vision to be processed automatically and reduce staff time required for marking. Videos can also include visual features to highlight key components in the experimental setup or any other important information. An example video can be found **here**.



TECHNICAL GUIDANCE

- A good quality video is required; recommend a 12MP camera or better.
- An external (lapel) microphone is preferred, try to reduce surrounding noise such as other equipment working nearby.
- For video editing and to insert visual features Adobe Premiere or Adobe Premiere Rush can be used (University wide license available).
- To insert quizzes in the videos Camtasia is suggested (requires a license)
- Alternatively, Microsoft (MS) Forms can be inserted in videos when hosted on MS Stream.

RATIONALE

How does the activity address the learning outcomes?

Students will be able to see the actual lab setup in operation with clear explanation of the operation. The quizzes or questions over the course of the experiment will improve engagement acting as a 'gate' to allow release of information or progressing to the next step. The additional visual features will draw student's attention to key aspects of the setup or the theory and give them even more insight than a traditional lab This is something that could be achieved using Augmented Reality (AR) in a traditional laboratory setup.

Strengths

- Use existing equipment, so can also benefit students in their preparation for physical labs.
- Allow student to see and engage with experiments in other campuses/places.
- The quizzes will act like a gate to decide the course of the video and the relies of the results which might improve engagement.
- Allow complete asynchronous delivery.
- Can be integrated with Vision or any other LMS

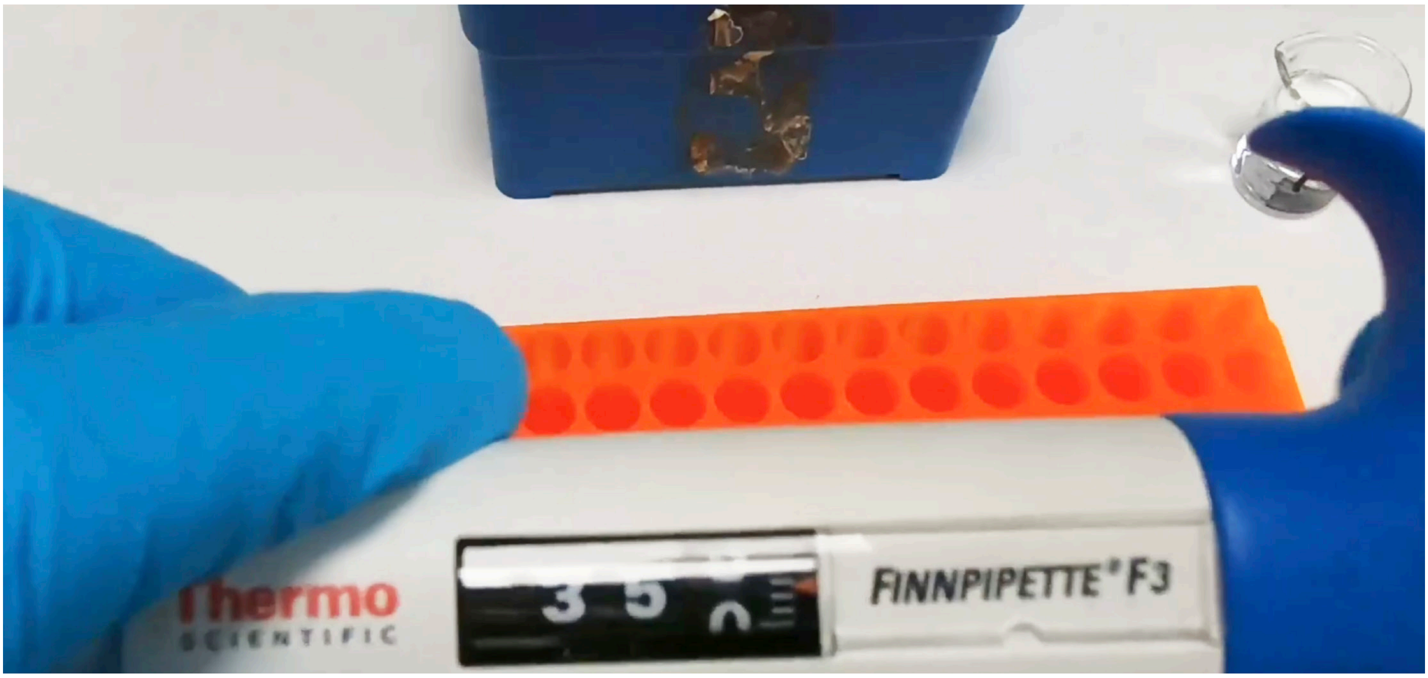
Limitations

- Doesn't involve hands on and motor skills development.
- Some software options require license
- Require significant staff time and editing skills to setup

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Conceptual understanding of how ecotoxicological data was generated in the laboratory
Data analysis and interpretation
Judgment of data quality and decision making
Scientific report writing

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

Biology **PGT**



DESCRIPTION OF ACTIVITY

Students would normally generate their own data in a series of intensive lab sessions. Here, demonstrations of these labs have been recorded in a 'first person' style. There are a series of short videos of these assays being performed with an explanation of what is being done and why.

Here is an example: **https://web.microsoftstream.com/video/e80cd1b0-f87e-450a-b396-d12b526cdc8c**

TECHNICAL GUIDANCE

- A GoPro (not supplied by the University) and a Document Viewer/Visualiser has been used in these recordings
- You can use the **Resource Booker** to find a location with a Visualiser
- The 6min example took 2 days to film, edit and voice over

RATIONALE

How does the activity address the learning outcomes?

These are specialized assays for which there are, at least to my knowledge no commercially available simulations available with the learning outcomes my students require. This approach may not give the students the 'hands-on' practical skills training normally offered by the programmes but it will prepare them for a return to labs and compliments the real experience.

Strengths

- Maintains the lab component in the course

Limitations

- The lab experience is not the same but will prepare students for a return to the labs in semester 2 and the MSc project phase, as social distancing guidance allows.

5 STAFFED LIVE-ONLINE DEMONSTRATED LAB: Electronics Demo

Dr Keith Brown, **EPS**

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Analysis of experimental data
Training in use of equipment
Understand the importance of physical units of measurement
Troubleshooting
Planning of experiment
Experience
Following of standards
Health and Safety practices
Dealing with uncertainty
Learning through failure
Use a range of numerical and graphical skills

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

Science and Engineering UG and PG Laboratory Exercises

Most suited to year 1 or 2 students but could be used for later years

DESCRIPTION OF ACTIVITY

Take a simple electronics experiment online using Collaborate Ultra. Go through the experiment but using polling to help choose how things are set up and connected. Try to end up with some things done incorrectly so that the students can see why certain things need done. Let the students select values of components and choice of measurement equipment ranges. Interacting through the chat and polls whilst showing the experimental equipment will help to keep student interest compared with a straight recording. Important to not try to do too much as student interest will probably start diminishing. This allows equipment that cannot automatically be connected to computer control to be used remotely, but it does need to be in synchronous sessions (these can be recorded for watching non-interactively asynchronously).

TECHNICAL GUIDANCE

Appropriate web cams and microphones need to be available together with a networked computer for running the collaborate session. Recording the session and then editing will provide a resource for students to review afterwards (or see for the first time if they miss it).

RATIONALE

How does the activity address the learning outcomes?

It allows all of the things that go on during an experiment to be experienced by the student (except the hands on part of the activity).

It means non-automated experiments can be made available for remote operation.

Students still choose (albeit collectively) components and equipment choices.

Students can get data for analysis and further interpretation.

Gives a better feeling for the equipment than just a computer control panel interface

Strengths

- Many aspects of a real experiment covered
- Doesn’t require much effort to set up
- Students can interact in real time

Limitations

- Only works synchronously and needs staff to run it.
- Doesn’t involve hands on and motor skills development
- Some students may not engage
- For best and most interactive experience, this lab should be conducted in small groups

Dr Maria Ana Cataluna, **EPS**

EXPLICIT AND IMPLICIT LEARNING OUTCOMES
Analysis of experimental data
Understand the importance of physical units of measurement
Teamwork skills
Troubleshooting
Planning of experiment
Following of standards
Health and Safety practices
Dealing with uncertainty
Learning through failure
Use a range of numerical and graphical skills

DISCIPLINE AREAS OR PROGRAMMES THE ACTIVITY WOULD BE SUITABLE FOR

Physics, mechanics, fluids, image analysis.

Better suited for Y1 and Y2, but elements of this could be adapted for some activities in Y3.

DESCRIPTION OF ACTIVITY

This is based on a special **'bridge project'** at Durham University, where small groups work on a simple, open-ended 'invention' project which typically lasts 1 week. The activity was run fully remotely and more information is shared **here** (starts at 23m38s).

The projects run over a 2-week period, with groups of 4 to 5 students and a choice of 6 possible projects. The projects relied exclusively on items which can be easily found at home and making use of smartphones and the sensors that can be found in them (microphone, camera, accelerometer + other apps). Some examples of this included:

- Constructing models of Sycamore tree seeds and studying their flight (using video analysis or stopwatch).
- Measuring the speed of sound in water and investigate how this change with various conditions (for example, in the presence of bubbles, which could be generated by mixing lemon juice with baking soda). Investigating resonance in a wine glass.
- Capturing and analysing the splash made by a marble dropped in a bowl of water. Investigating what is the influence of several factors such as drop height, or water depth, or distance from the edge of the bowl, using image or video analysis.

The students worked and collaborated remotely on these projects.

Many elements of this could be adapted to some practice-based activities, with varying degrees of 'open-endedness'.

This case study describes a successful implementation by Durham University, led by Dr. Aidan Hindmarch in June 2020 (Physics Department).

TECHNICAL GUIDANCE

Each group of students collaborated and discussed on MS Teams and used Office 365 (OneNote, Excel and Powerpoint).

Each group of students met regularly with a member of staff on MS Teams, and in addition to this, there was a daily online manned 'office hour' for drop-in discussions/troubleshooting (also on MS Teams).

RATIONALE

How does the activity address the learning outcomes?
This activity can address the lab learning outcomes listed above, as long as there are ways to capture and make measurements. Lab books can be kept (and assessed) using OneNote.

Assessment was also based on presentation slides produced by the students - this could be further extended to a live presentation and/or to a report.

Strengths
- Hands-on activities.
- Students work in teams, which develops group work skills, enables peer support and social interaction.
- As there is no limitation to materials/equipment, students can choose the experiments they want to tackle from a list of options (potentially increasing student engagement).
- Can help make the link between everyday life and the phenomena they are investigating.
- Can help develop further creativity, confidence and independence.

Limitations
- Limited opportunities for training in use of industrial-grade equipment (this could potentially be addressed in a subsequent academic year in a 'bootcamp week').
- Some students may perceive this as 'not real experiments' (when compared to the traditional in-lab setups) and not engage. This could be addressed by driving home the message that while the experiment might look simple, the data capture, analysis and understanding will continue to be challenging.

STUDIOS GUIDANCE

Teachers typically use studio-based learning in the fields of architecture, design, engineering, and creative and performing arts. Studio based courses are usually delivered in a flexible learning environment which transforms between a lecture setting, to discussion groups, to a mini workshop, to one to one tutorials, and even takes the form of an exhibition and showcase at times. In all its transformations, there are key explicit and implicit learning outcomes that the learning environment facilitates.

The 'studio' is normally a dedicated classroom, design or performance space, but may also be a constructed social environment in a virtual space, or a personal space.

In the current pandemic circumstances, not able to access the design studio raises the following limitations:

1. **Demonstration of techniques: in a design studio, the tutor can demonstrate various essential techniques associated with drawing and related tools.**
2. **A tutor in a design studio takes advantage of the flexibility in addressing the whole class, or a working group or an individual, as needed, seamlessly and without interruption. This could be done repeatedly in a session as required.**
3. **Peer to peer learning: In a studio setting, successful interventions and examples are openly discussed. Peers often observe other's project for progress and inspiration.**
4. **From student perspective, the convenience of sharing both hand drawn and digital design development / course work for formative feedback.**
5. **Design courses usually have invited critics to review student works at the end of the semester. This will be a challenge in the current circumstances.**
6. **Studio based courses are usually linked with key workshop spaces such as the D6 Architecture's Fabric Form Facility or the sewing workshop of SOTD. Design deliverables should be reassessed considering limited access to such workshop spaces.**
7. **Access to the library for precedence and literature studies is important to design development. This again would be a challenge in the current circumstances.**
8. **The Studio environment defines the student learning experiences in a design program.**

TYPES OF LEARNING OUTCOME

The table below lists the types of learning outcomes typically addressed by studio-based courses. The table includes both *explicit* learning outcomes – described to students and listed in course documents – and *implicit* learning outcomes

EXPLICIT	IMPLICIT
Prepare design projects using a range of media, and in response to a studio brief.	**How to work in groups and individually.**
Demonstrate conceptual development of a relevant idea and articulate its process.	**How to communicate (as a sketch and verbally), research and investigate relevant ideas**
Produce coherent visual and verbal presentations of a design project.	**Peer to peer learning and design discussions**
Application of Theory	**Critical thinking and inquiry based research.**
Hands on with equipment / tools	**Time management**
	Personal responsibility
	Organisation and documentation

TOP TIPS

Here are somethings to bear in mind when developing alternative ways of addressing the explicit and implicit learning outcomes typically associated with studio-based activities.

1. Online studio-based activities do not replicate actual studio experiences. In a normal year, virtual studio-based activities are good ways to provide a reference resource after working in the studios and some virtual activities can be used as preparation for undertaking studio-based work.
2. Remember that online 1-to-1 sessions tends to take longer time than in an actual studio. Reducing the uploading / downloading of student course work for regular tutorials would significantly reduce the tutorial time while improve student learning experience. You can also ask students to upload the coursework the night before the tutorial which would then give you some time to review the student work prior to the tutorial.
3. Studio-based work is highly visual and experiential and online activities need to reflect this with the use of images, videos etc.
4. Maintaining student group/pair and peer-to-peer work online is crucial in assuring the students achieve many of the learning outcomes.
5. Remember you will have some students on campus and some online. Think deeply about how you will structure the activities so that both sets of students can achieve a similar experience. How will you achieve this blend of delivery?
6. 1-to-1 support and peer support as key components of studio-based activities can still be done online so, don't worry about this.
7. A detailed course schedule that identifies key stages of the project along with both summative and formative feedback opportunity will significantly help in the delivery of the design-based courses.
8. If feedback is given through sketches and diagrams, using a suitable drawing tablet instead of the mouse would be easier and more accurate.

EXAMPLES

Alternative activities are provided here. Each example describes one way in which the learning opportunities normally provided by conventional studio-based activities can be offered in the current context, within the limitations of physical distancing and making use of technology.

1. **Tutorials – ONLINE:** In an physical studio, 1-to-1 tutorials not possible for all students in the time allowed, so unfair and impractical for individual tutorials to be offered in person. Screen share and live digital commenting and engagement are effective using One Drive and Teams.
2. **Juries – ONLINE:** If in person, there will be a limit to people attending and distancing would make any review impractical
3. **Lectures – ONLINE:** cannot accommodate large groups in person, so best to be online and possibly recorded so students can re-watch
4. **Workshops – F2F:** hybrid formats of workshops will be easiest and most effective in person, so long as paper is not shared
5. **Workshops – Online:** If students have to work from home then using tools like the D6 Toolbox can help them to develop alternatives such 'How to make a study model from whatever materials they have at home?'.
6. **Individual work:** Online-Getting students to develop their own videos using for example Adobe Rush, Microsoft Streams or another tool.
7. **Charrettes/crits/ – F2F:** intensity of the charrette format will be best in person and will be possible with physical distancing
8. **Group discussions – F2F:** small group discussions can be facilitated in person, allowing fluidity of discussion
9. Some of the popular design standard books are available as e-books. Direct links to these on Vision would encourage students to refer and facilitate independent learning.

STUDIO GUIDANCE RESOURCES

Martijn de Geus: Tips for Design Studio Teaching in the age Covid19:
https://www.archdaily.com/936580/tips-for-design-studio-teaching-in-the-age-of-covid-19

Tips for Teaching Studio Art Online by Clara Lieu (RISD):
https://www.youtube.com/watch?v=ncpoiJCf1xo&feature=youtu.be&fbclid=IwAR2Kn6ae3Xly8G98KaNlYtiQ_LpUFjvtlodlH53vHvbz2E7lqmqH7zWlbOQ

Seven Ways to Move Your Design-based Class Online By Lesley-Ann Noel:
https://distancedesigneducation.com/2020/03/17/seven-ways-to-move-your-design-based-class-online/amp/?__twitter_impression=true&fbclid=IwAR3UUJ1gQO_UrRpHncCUHSVtuju7RJHBhIwCuOLwSEAOQdqUDEtnrp9zMt0

Want to Study Architecture? Online Learning Could Be Your Answer!:
https://www.arch2o.com/study-architecture-online-learning/

LABS GUIDANCE RESOURCES

Enhancing Digital Teaching & Learning in Irish Universities: Considerations for Lab-based Subjects.
https://edtl.blog/the-edtl-approach/edtl-approach-considerations-for-lab-based-subjects/

Gibbs, B. & Wood, G. C., eds. (2020). *Emerging Stronger: Lasting Impact from Crisis Innovation.* Godalming: Engineering Professors' Council.
http://epc.ac.uk/wp-content/uploads/2020/08/Gibbs-Wood-eds-2020-Emerging-Stronger.pdf

ADDITIONAL RESOURCES

Additional resources can be found in '*Practice-based activities: Labs, studios and fieldwork*'.
https://lta.hw.ac.uk/wp-content/uploads/03_RBL_Practice-based-activities.pdf

HERIOT WATT UNIVERSITY | LEARNING + TEACHING academy

CONTACT US
E: LTAcademy@hw.ac.uk

FOLLOW US
@LTA_HWU

www.lta.hw.ac.uk