Technology to Sustainably Support Laboratory Learning

Two Perspectives on Screen Experiments & Their Application

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Today

Introduction to Screen Experiments

Part 1 – Durham University (SN)

• Case Study 1 – Supporting Students Transitioning into 1st Year
• Case Study 2 – Widening Access through Foundation
• Case Study 3 – Supporting Conceptual Understanding in QM
• Other Uses 😊

Part 2 – Open University / Great Central Consulting (PH)

• Distance Learning
• Developing Sustainability

Overall Conclusions & Future Work
What are they?

Inspired by ISEs developed at the Open University


‘a highly interactive movie of an experiment filmed as that experiment was being performed’

- User interacts with movie as if carrying out the experiment
- At Durham carried out prior to real lab
How do you make an ISE?

1. Take an experiment
2. Storyboard interaction
3. Take photos
4. Develop into a teaching tool
5. Stitch together
Work of Kirstein (2009) deployed ISE prior to a laboratory session, and split the 58 students into two groups

- Test Group – used the ISE & read the script
- Control Group – read the script
Work of Kirstein (2009) deployed ISE prior to a laboratory session, and split the 58 students into two groups:

- Test Group – used the ISE & read the script
- Control Group – read the script
Part 1: Student Developed ISEs @ Durham
Case Study 1: Physics Dept. Level 1

- **Physics Dept**
  - Used with 1st year undergraduates

- **Main issue**
  - Disparity of practical physics experience at school
    - Some – significant experience
    - Many – very little
  - Used to overcome anxiety caused by lack of experience
  - Deployed as a summative pre-laboratory task

Case Study 2: Foundation Centre

- **Foundation Centre:**
  - Local mature students
  - International students
  - The diversity of the cohort is a strength, but in this study each student group had its own issues
  - Local mature students: often little formal education in their recent experience
  - International students: learning in a second language
  - Both have somewhat of a culture shock
  - ISEs used as pre-laboratory tasks to overcome anxieties
Case Study 3: Physics Dept. Level 3

- **3rd Year Quantum Optics:**
  - New model to teach quantum mechanics with an emphasis on single photon experiments
  - At Durham we have a 3rd year extended lab on Bell’s Inequalities
  - Created an ISE on this experiment, which:
    1. Builds experience of single photon detector apparatus
    2. Builds skills in single and double crystal polarization states
    3. Allows a calculation of Bell’s Inequalities
  - Can be adapted by teacher to deliver all or a subset of (1-3)
  - Working with St. Andrews to create a simulation and ISE which complement each other
ISE demo

Callipers ISE

1. Read the introduction to using a set of callipers

2. Learn how to use the callipers to take measurements

3. Get virtual hands-on experience by completing the ISE

http://level1.physics.dur.ac.uk/ISE/Callipers.php
Walk Through of Circuit Building

A resistor is placed in the circuit. A resistor restricts the flow of current, slowing down electrons as travel from negative to positive.

Developed for article with Physics Education
http://obspc23.phyast.dur.ac.uk/FullVersionA1.swf
Quiz on Building Experiment
Drag and drop the appropriate equipment to build the experiment

Click to Start the Quiz

http://obspc23.phyast.dur.ac.uk/Main_Content_Aspirin_MAC_A3.swf
ISEs (with Augmented Reality) for Chemistry

http://obspc23.phyast.dur.ac.uk/Aspirin3.swf

Seeing with a scientific eye
ISEs (with Augmented Reality) for Chemistry
ISEs (with Augmented Reality) for Chemistry

Seeing with a scientific eye

An ester bond is formed to make acetyl salicylic acid (Aspirin).
ISEs (with Augmented Reality) for Chemistry

Level 3 Chemistry
AR ISE Under Development
ISSEs for Overcoming Fear of Maths

See http://calculatorise.wordpress.com/
Based on ideas from “Adult understanding in mathematics”,
Example: Level 3 – Quantum Optics

http://hurstkatherine.wordpress.com/
Student Developers

- All students involved were recent veterans of the laboratory classes.
- Students were employed to be involved in all parts of the development cycle.
- This has been going for five years now.
- Almost ever year, the last year’s student acts as a consultant to help this year’s student.
The Pro’s

For Students, Student Developers and Teachers
What did the student developers get out of it?

- Chance to improve the learning experience of other students
- Skills in Flash/HTML5 programming and digital photography
- Experience in driving a project
- Experience in writing up project
What did the student learners get out of it? (Level 1 & Foundation)

End of module questionnaires

- ‘The interactive screen experiments (ISEs) provided as preparatory tasks for some of the Full Experiments helped my understanding of the experiment.’
- Of the 191 responses 131 students agreed or strongly agreed.

Focus groups

- 'I used the experiment as soon as you sent it out, before the class, after the class and when I was writing the report. I haven’t done practicals in Brazil and really appreciated this.’
- 'I wish we could have had more of these sent out earlier to give us something to do over the summer.'
What did we get out of it?

- Development of 15 ISEs (in Physics, Chemistry, Biology & Maths)
- Physics website cited by BBC as a resource to explain the concept of experimental errors
- Additional funding to study impact on student learning
- Additional funding to host workshop
- Many summer students progressed on to PhDs
- New development ideas:
  - ISEs to support staff understanding of carbon footprint
  - Internal mapping of buildings using Wi-Fi hotspots
  - Working with RSC on review of ISEs
The Cons
Sustainability

- Institutional Support (level of few k per annum)
- Limited but growing reach
- Seek funding from IOP, HEA, etc.
- Deal with longevity of ISEs
  - New Lab Equipment
  - Move from Flash to HTML5
General Conclusions
Conclusions & Future Work

- Each case has enriched the learning of the students generating the content and those using it.
- The skills developed by the students generating the content are both subject specific and general (personal–transferable).
- Future work
  - More screen experiments
  - Deep quantitative research, e.g. Kirstein et al.
  - Deeper qualitative research: “How do ISEs impact laboratory learning?”
With Thanks To

• Level 1 ISEs
  • Lowry McComb, Marek Szableswki, Ifan Hughes, Dan Maxwell, Matthew Shipton

• Chemistry ISEs
  • Simon Rees
  • Julitta Gasowska
  • Andres del Castillo Dubuc

• Level 3 ISEs
  • Matt Jones, Antje Kohnle, Katherine Hurst, Dan Maxwell

• Maths ISEs
  • Mary Dodd, Rachel Dunn, Andres del Castillo Dubuc
A Different Perspective

Practical science at a distance

Online practical science modules

Wolfson Open Science Laboratory

An enthusiasm for experimental science

An enthusiasm for distance learning

Interactive screen experiments (ISE)

A pedagogy of virtual experiments
The OpenScience Laboratory

http://learn5.open.ac.uk
Function of the OpenScience Laboratory

OpenScience Laboratory

- Interactive practical science to students anywhere and anytime
- Resources for all and for registered users
- Multi-disciplinary – currently over 40 resources online
- Not tied to a module – Flexible use

Resources of all sizes:

- Focused – eg Flame Test
- "Citizen Science" – eg Treezilla
FutureLearn

Online courses from a consortium of UK and International universities and institutions

Learn anytime, anywhere

Enjoy learning one step at a time, wherever you are, whenever you want: on mobile, tablet or desktop.

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A key feature – accessible across devices – flexibility of learning environments

http://www.futurelearn.com
FutureLearn

- Open access – generally no pre-requisites
- “Social” learning – connecting students
- Multi-disciplinary
- Cross-platform
- Challenges for online practical science

Free!

Great for “leisure learners”

What about accreditation?
Matters Arising in the ISE Cycle

- ISE scoping and development
- Sustainability
- Researching and validating ISEs
- ISE dissemination
Sustainability

Personnel

Are one-off projects sustainable? If not, who do we go to?

Student needs

How do these change? Dependent on use? Responsiveness?

Apparatus

What tools are used? Are they supported? Openness?

Tools

Need for cooperation? No need to re-invent wheel? Sharing production?
Identifying a Need – a Personal View

- **Getting started with virtual laboratories and ISEs**
  - Where to start?
  - Where to learn about techniques – and pitfalls!
  - Don't want to re-invent the wheel

- **Keeping ISEs “live”**
  - What happens when students/postdocs move on?
  - Combating new “technical” problems
  - Addressing changes to students' use of IT
  - Exploiting new platforms (eg, FutureLearn?)

- **Evaluating**
  - Would an independent presence help in data collection and analysis?
Introducing Great Central Consulting

“Spinning off” from the Open University

Academic background

Independent and impartial

Education Focus

Flexible and responsive

Great Central Consulting Education Consultancy Partnership
What do we want to do?

- **Working with institutions and organisations**
  - To produce both custom and generic ISEs and resources
  - To provide a level of sustainability to the virtual laboratory world
  - To provide assistance in learning the methods and principles of ISEs (CPD)
  - To help with evaluation as independents with no vested interest
  - To bring the ISE and virtual laboratory concept to all levels of education
  - To ensure both the benefits and drawbacks of ISEs are well-understood through scholarly reports and articles
  - To help disseminate best practice
  - To help identify new challenges and methods in virtual laboratory practice
  - *To keep using our experience and skills*
With Thanks to:

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- HEFCE
- Many others for support and inspiration...