

# Virtually better than the real thing: the hopes and realities of remote experiments



Nick Braithwaite  
&  
the OpenSTEM Labs team

# Virtually better than the real thing: the hopes and realities of remote experiments

Design => new build not retro-fit

Easy reach => browser interface

Useful => embed in curriculum

Used => embed in assessment

Reliable => must work/fail well



Historical perspective: practical enquiries at a distance

- Home experimental kits  
microscopes, skulls, chemicals, lasers, rubber balls etc
- TV broadcasts ...videos
- Residential laboratory based classes  
6 day residential practical programmes
- Interactive Screen Experiments (real data)  
CD/DVD by mail ... internet
- Remote (and virtual) : The OpenSTEM Labs



Experiments at home (~1975)

## Historical perspective: practical enquiries at a distance

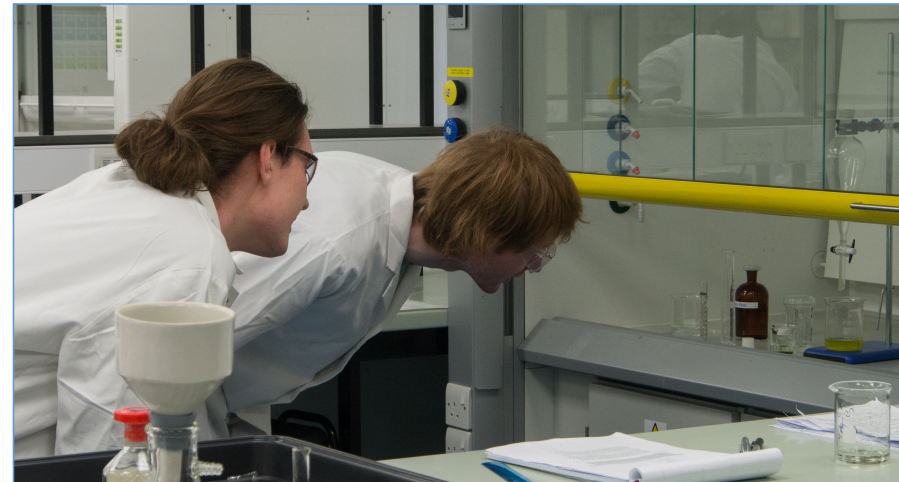
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Experiments on TV  
Russell Stannard (after midnight, ~1978)

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Experiments in a (borrowed) lab location  
Residential Schools (~1990)

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### Experiments in software: diffraction (~2006)



Hatherly, P.A.; Jordan, S.E. and Cayless, A. (2009).  
Interactive screen experiments: innovative virtual laboratories for distance learners.  
*European Journal of Physics*, **30**(4) pp. 751–762.

## Historical perspective: practical enquiries at a distance

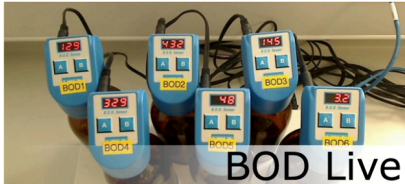
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**OpenSTEM Labs**



2018



BOD Live



Remote experiments ... from 2009

## Historical perspective: remote labs 2002-2004



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)



Computers & Education 43 (2004) 153–163

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[www.elsevier.com/locate/compedu](http://www.elsevier.com/locate/compedu)

### Remote experiments, re-versioning and re-thinking science learning

Eileen Scanlon <sup>a</sup>, Chetz Colwell <sup>a,\*</sup>, Martyn Cooper <sup>a</sup>, Terry Di Paolo <sup>b</sup>

<sup>a</sup> Institute of Educational Technology, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK

<sup>b</sup> School of Health and Social Welfare, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK

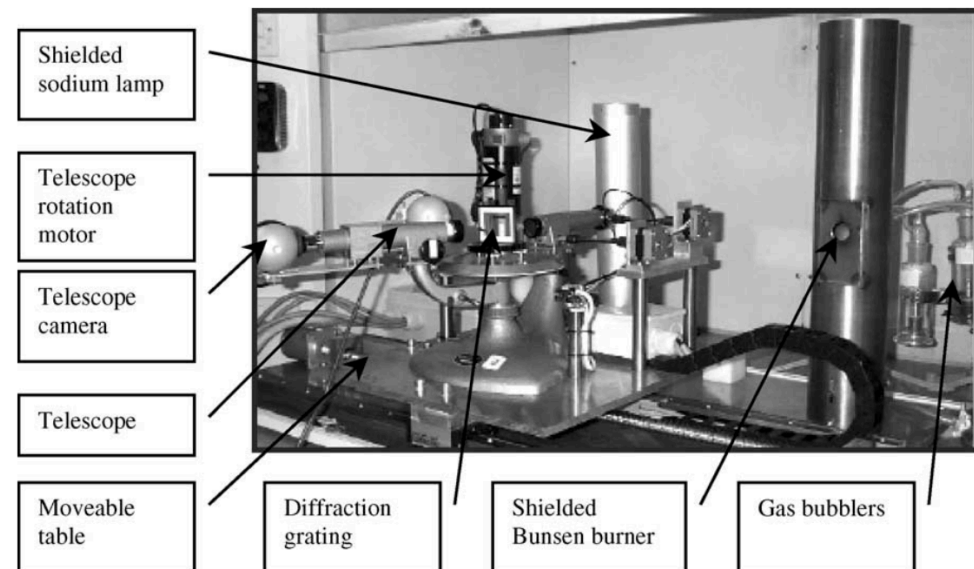


Fig. 1. Annotated photograph of motorized optical spectrometer jig for the OU experiment.

## Historical perspective: remote labs 2002-2004



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)



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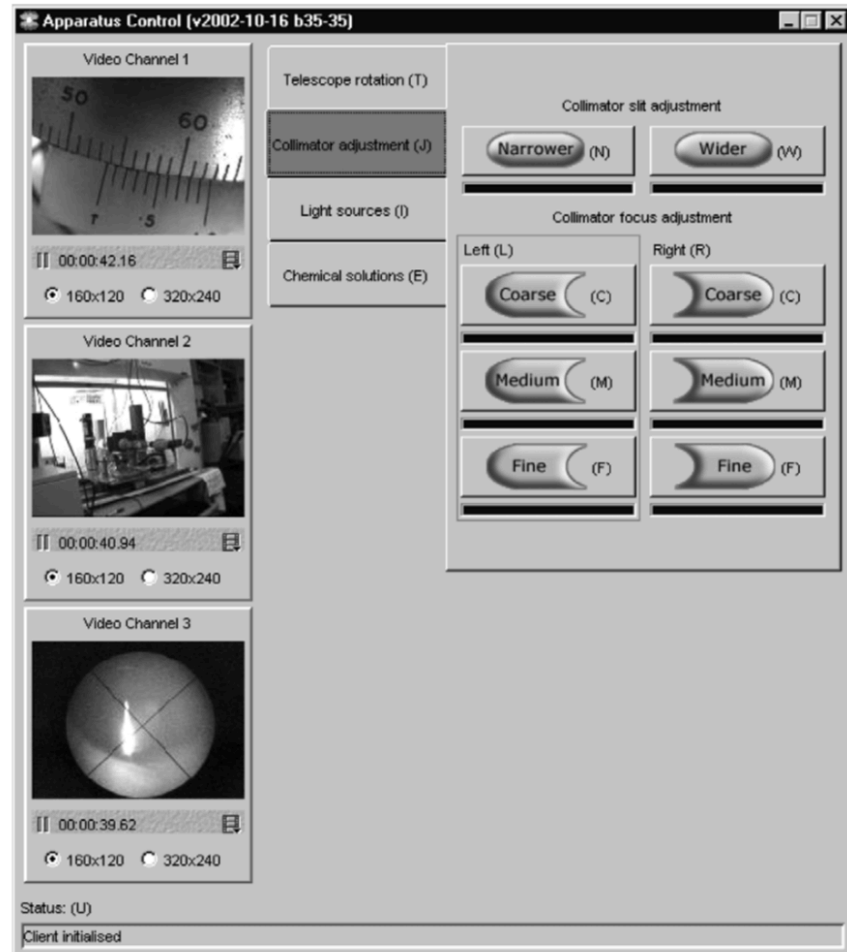
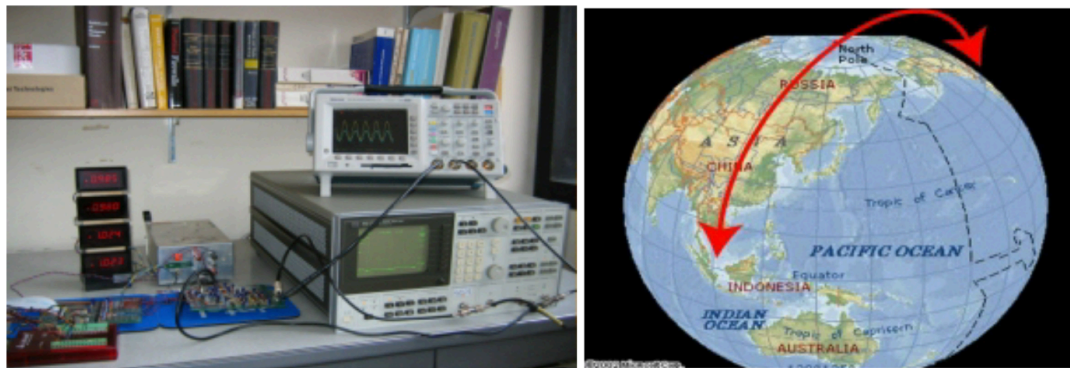


Fig. 2. Screenshot of the user interface developed at the OU to control the remote spectrometer jig.



## Historical perspective: remote labs 2006-19

### iLabs



### iLab Project at MIT

As of 2019, the iLabs project at MIT has come to a close. This site is being left online as a historical record.

### About iLabs

*iLabs* is dedicated to the proposition that online laboratories – real laboratories accessed through the Internet – can enrich science and engineering education by greatly expanding the range of experiments that students are exposed to in the course of their education. Unlike conventional laboratories, iLabs can be shared across a university or across the world. The iLabs vision is to share expensive equipment and educational materials associated with lab experiments as broadly as possible within higher education and beyond.



## Global Online Laboratory Consortium + International Association of Online Engineering 2016 - present

The image shows two overlapping screenshots of the IAOE+GOLC website. The top screenshot displays the 'GOLC – Mission Statement' page, featuring a blue navigation bar with links for Home, IAOE, GOLC, VISIR Federation, SIGs, Resources, Activities, News, and Member Login. The main content area includes the mission statement: "The mission of the consortium is the creation of sharable, online experimental environments which increase the educational and scientific value of learning which may not be accessible, scalable or efficient through traditional methods." A sidebar on the right lists 'GOLC' with sub-links for 'About GOLC', 'Leadership', and 'Members'. The bottom screenshot shows the 'IAOE' page, with a similar navigation bar. The main content area describes the International Association of Online Engineering (IAOE) as an international non-profit organization. It states the objective of encouraging the wider development, distribution and application of Online Engineering (OE) technologies and its influence to the society. It also mentions that the association seeks to foster practices in education and research in universities, higher education institutions and the industry on OE. Furthermore, it notes that the IAOE promotes OE for the improvement of living and working conditions, encourages the exchange of knowledge as well as the exchange of staff and students between co-operating institutions, and was founded by Michael E. Auer, Andreas Pester and Heimo Ressler as a non-profit association by Austrian law in 2006. A sidebar on the right lists 'IAOE' with sub-links for 'About IAOE', 'iJOE – Outstanding Paper Awards', 'Membership' (with sub-links for 'Benefits', 'Types/Fees', 'Registration'), 'Leadership' (with sub-links for 'Executive Committee', 'Scientific Advisory Board'), and '...'. The bottom of the page is partially cut off, showing the start of the 'IAOE Activities Cover' section.

**GOLC – Mission Statement**

"The mission of the consortium is the creation of sharable, online experimental environments which increase the educational and scientific value of learning which may not be accessible, scalable or efficient through traditional methods."

This means especially:

- to encourage
- to sponsor t
- global netw
- to support c
- to lead the e

The Global Online accessible laborato increasing interest convert the curren world.

**IAOE**

The International Association of Online Engineering (IAOE) is an international non-profit organization with the objective of encouraging the wider development, distribution and application of Online Engineering (OE) technologies and its influence to the society.

The association seeks to foster practices in education and research in universities, higher education institutions and the industry on OE.

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The IAOE encourages the exchange of knowledge as well as the exchange of staff and students between co-operating institutions.

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**IAOE Activities Cover**

**GOLC**

- About GOLC
- Leadership
- Members

**IAOE**

- About IAOE
- iJOE – Outstanding Paper Awards
- Membership
  - Benefits
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  - Executive Committee
  - Scientific Advisory Board
  - ...

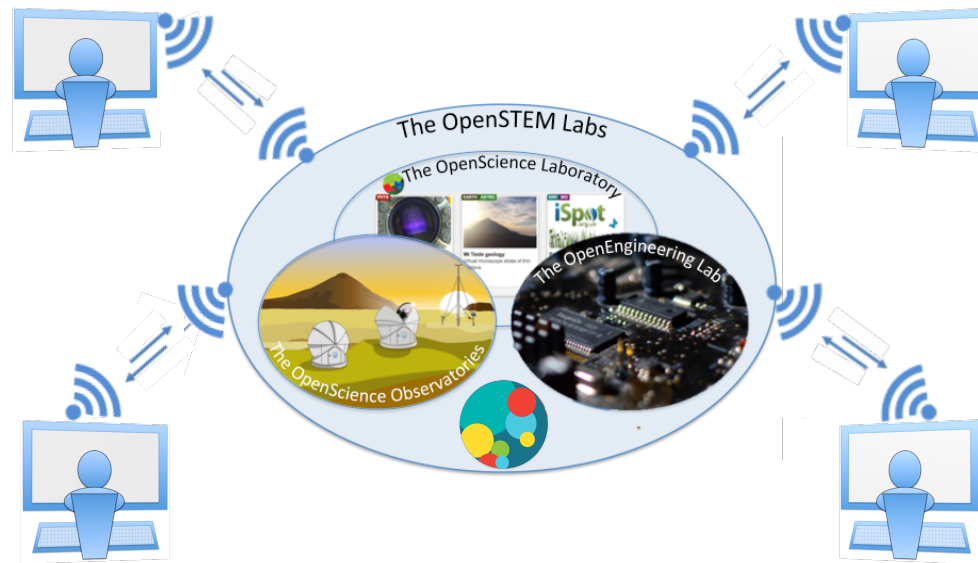
2006  
...2013  
...2015  
...2021



# OpenSTEM Labs



The Open University



Virtually better than the real thing

*The hopes and realities of remote experiments*

- .....an the Internet of laboratory things: big kit



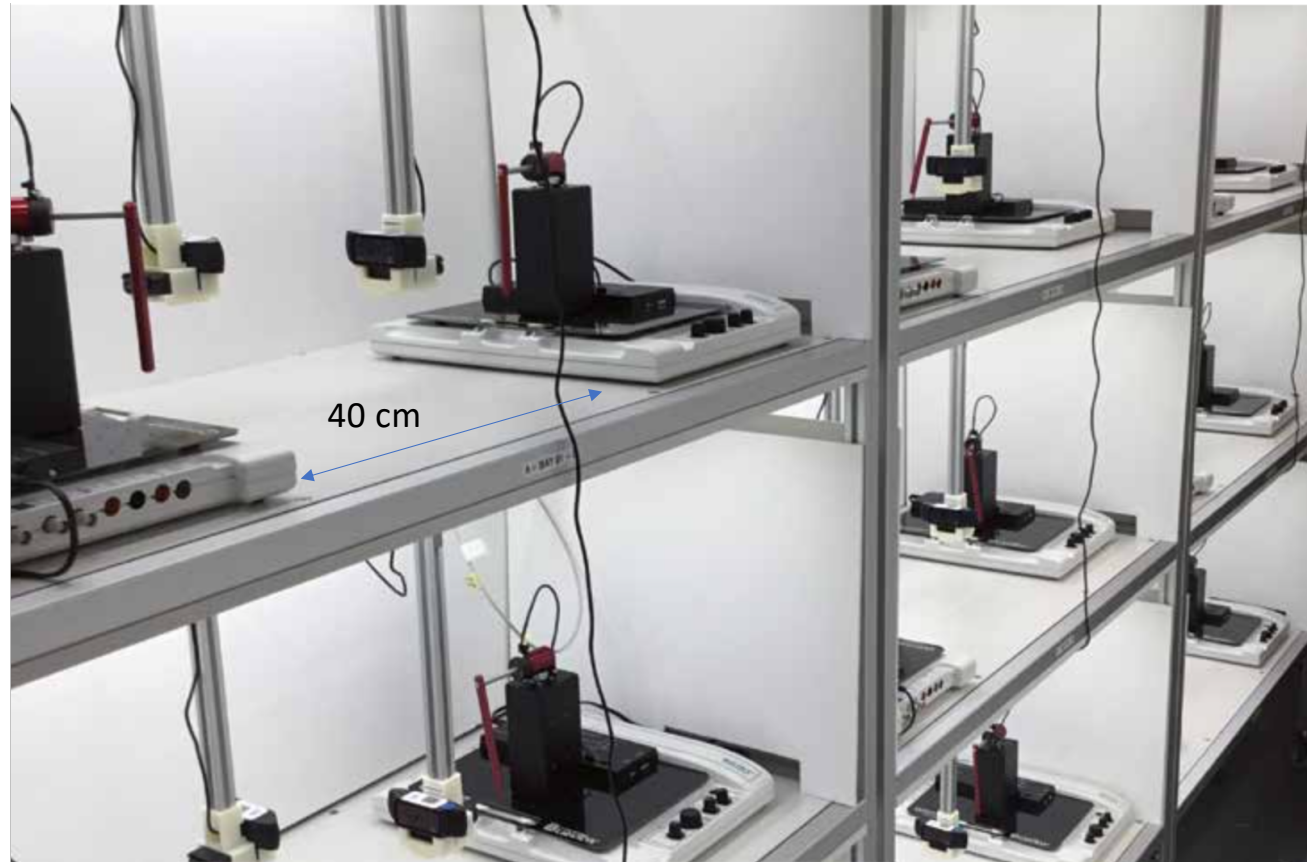
2 x Optical telescope  
1 x Radio telescope

Biggish kit  
2 x SEM  
4 x Wind tunnel  
2 x HPLC  
1 x FTIR  
2 x Optical microscope...



- .....an the Internet of laboratory things: big capacity

dozens of lab bench kits  
(3D)



## Headline impact of OpenSTEM Labs remote experiments (and other online practical activity)

- Core practical component of STEM qualifications in physics, astronomy, chemistry, life sciences earth and environment, engineering and computing ([>30, 000 student-hours of remote connection to labs pa](#))
- 50/150 OpenSTEM Labs activities use remote connections to real experiments (~5% improvement in progression)
- Commended in accreditations of engineering, biosciences and physics qualifications
- Commended in QAA and US University's Middle States accreditation reports

"I really enjoyed this module. Intellectually demanding with excellent exercises with robotic telescopes and microscopes and great academic staff. A real highlight was [Mars] Rover week which was easily the best team exercise I have done with the OU."

[Headline impact of OpenSTEM Labs](#)

## Headline challenges of OpenSTEM Labs remote experiments

Challenge	Mitigation
Acquisition (k£)	
Development (k£)	
Operationalise (k£)	
Functionality: Op sys + bandwidth	
Useability	
Uptake/engagement	
Satisfaction	
Work/fail well	
Credibility/acceptance	

## Headline challenges of OpenSTEM Labs remote experiments

Challenge	Mitigation
Acquisition (k£)	Capital investment initiatives
Development	Technical developer team
Operationalise	Embed in STEM curriculum ... => fees
Functionality: Op sys + bandwidth	Browser interface
Useability	Accessibility team
Uptake/engagement	Embed in assessment => must work
Satisfaction	Reliable => must work/fail well
Work/fail well	Design: New build not retro-fit
Credibility/acceptance	Showcase to QAA and accreditors

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Design => new build not retro-fit  
Easy reach => browser interface  
Useful => embed in curriculum  
Used => embed in assessment  
Reliable => must work/fail well

The OpenSTEM Labs team