



**ESTEEM**  
THE OU CENTRE FOR  
STEM PEDAGOGY

# A classification scheme for OpenSTEM Labs experiments

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The Open University



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University

- Background to OpenSTEM Labs
- Project aim and objectives
- Classification schemes for remote and online labs from the literature
- Proposed OpenSTEM Labs classification scheme
- Trials using classification scheme
- Initial findings

# Background

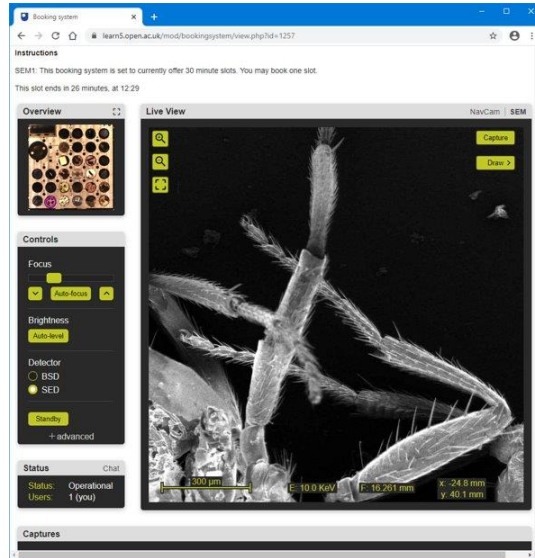
- The OpenSTEM Labs deliver authentic practical experiences to the Open University's distance learning students using real time instrumentation, data and equipment for practical enquiries over the internet
- Students interact with experiments via a web browser on their laptop or mobile device.
- The OU has developed more than 100 activities that are used by more than 10,000 students/year



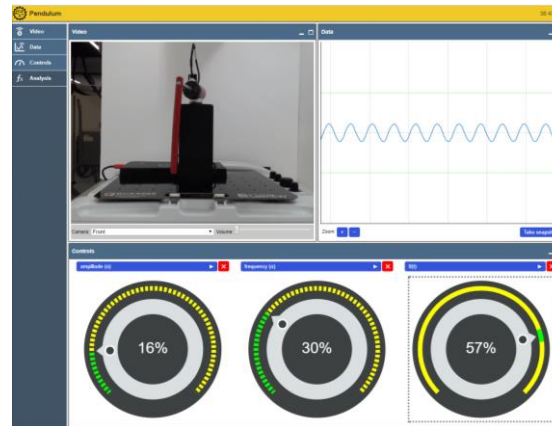
# Example OpenSTEM Labs activities



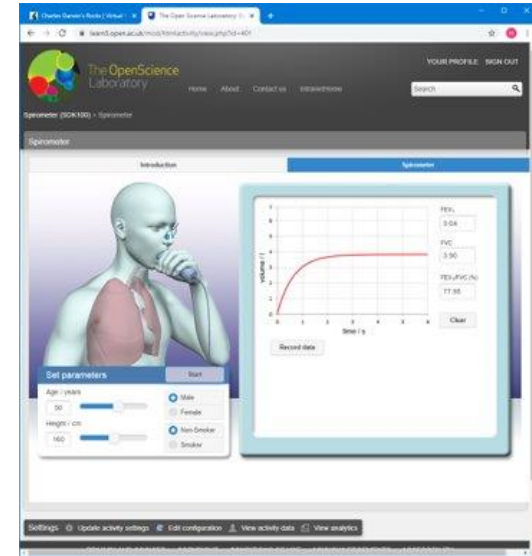
OpenScience Observatories



Scanning Electron Microscope



Controlling a driven pendulum



Spirometer

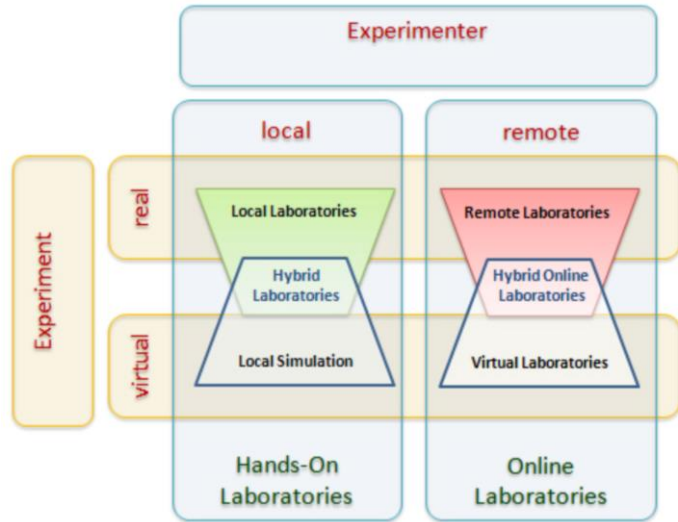
## **Aim:**

To explore the breadth of activities, skills and educational outcomes developed in OpenSTEM Labs experiments and develop a learning design tool to inform future OpenSTEM Labs activities.

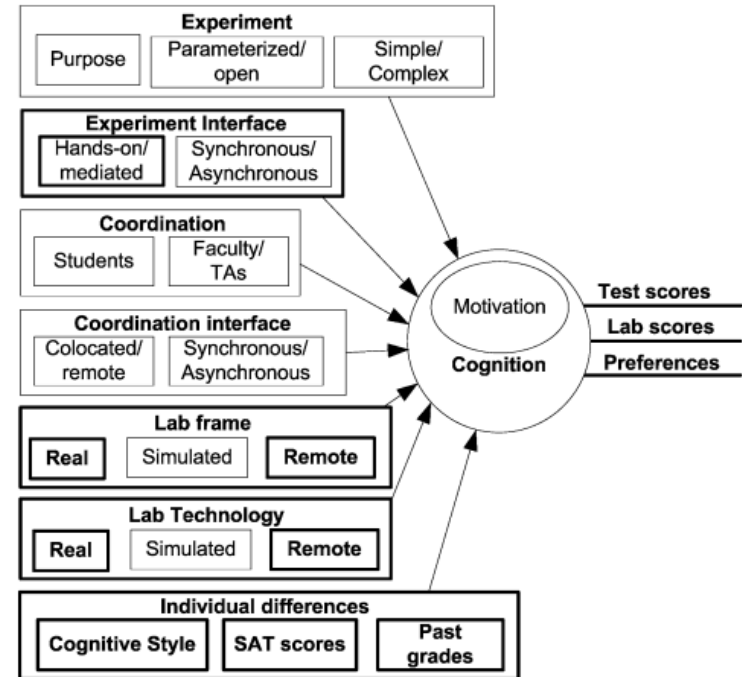
## **Objectives:**

- Understand how remote and onscreen laboratories have been classified in the literature
- Develop a classification scheme for OpenSTEM Labs activities and their learning objectives
- Create a database of existing activities to understand the range of activities available and their learning objectives
- Develop a design tool to help module teams developing new OpenSTEM Labs activities

# Classification schemes for remote/ online laboratories



Zutin et al. (2010)



Nickerson et al. (2007)

# Classifications schemes for learning objectives of remote/ online laboratories

## KIPPAS Learning Outcomes

Knowledge and Understanding

Inquiry skills

Practical Skills

Perception

Analytical Skills

Social and Scientific Skills

Brinson (2015)

## Fundamental Objectives of Engineering Instructional Laboratories

Instrumentation

Psychomotor

Models

Safety

Experiment

Communication

Data Analysis

Teamwork

Design

Ethics in the Laboratory

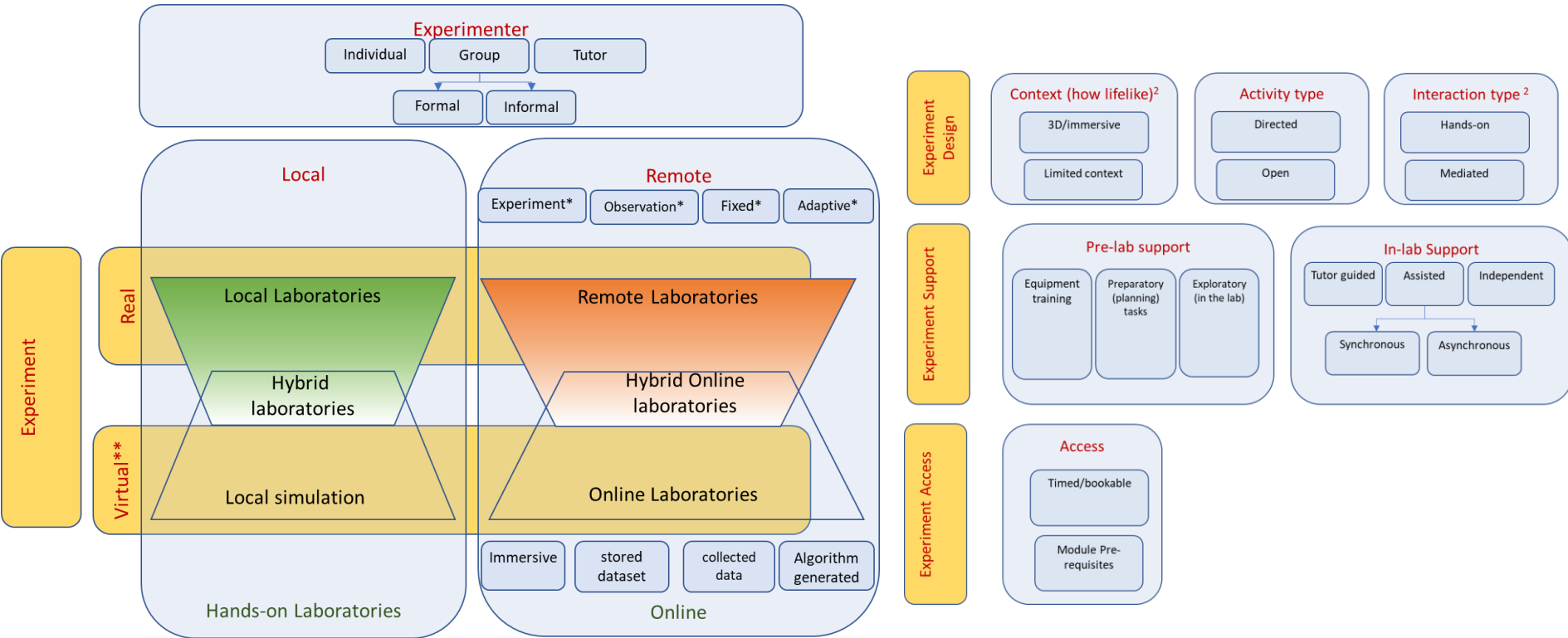
Learn from Failure

Sensory Awareness

Creativity

Feisel & Rosa (2005)

# Proposed classification scheme for OpenSTEM Labs activities



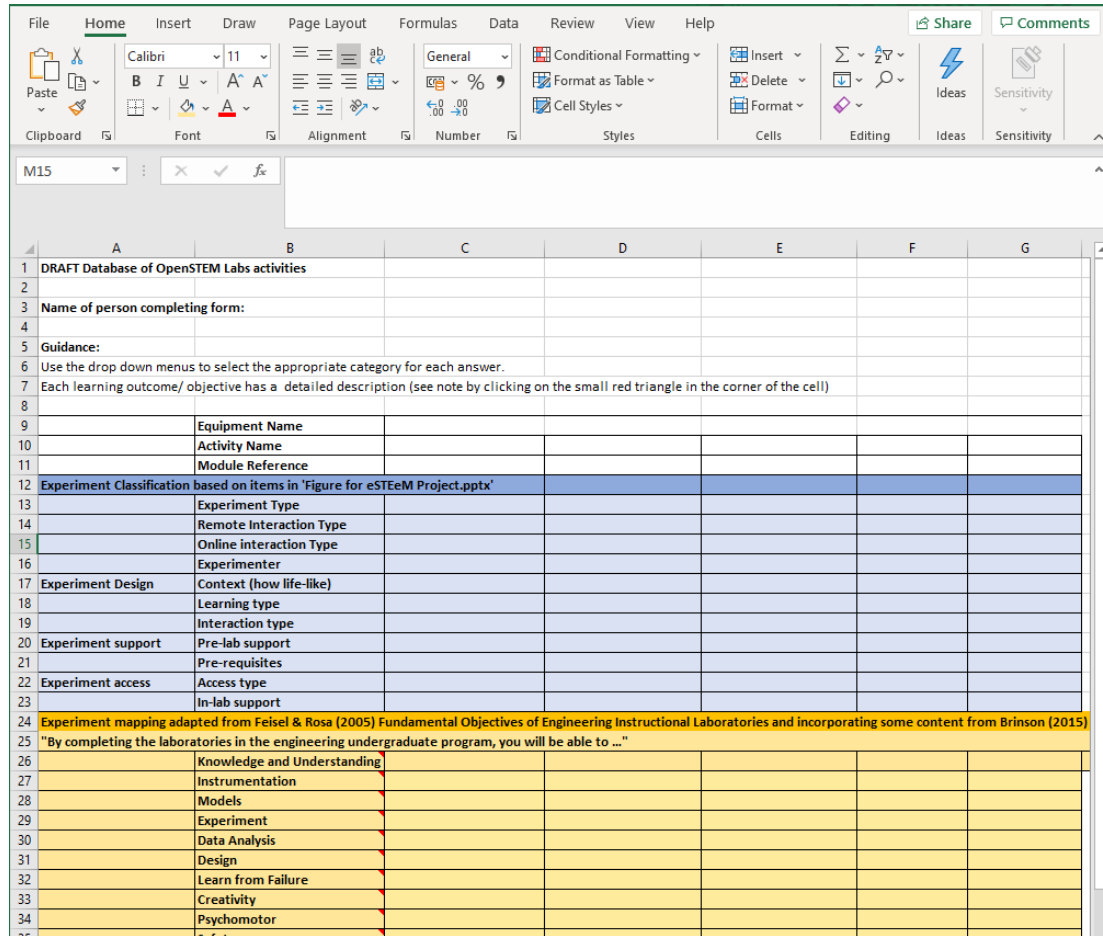
Developed based on Zutin et al. (2010) and others



# Proposed classification scheme for OpenSTEM Labs learning objectives

Apply subject knowledge and show understanding	Demonstrate creativity in problem solving
Apply appropriate instrumentation to make measurements	Demonstrate competence in operating apparatus
Use theoretical models to predict behaviour	Identify and deal with health and safety issues
Devise experimental approach	Communicate effectively about laboratory work
Collect, interpret and analyse data	Work effectively in teams
Design, build, or assemble a product	Behave with high ethical standards
Identify unsuccessful outcomes and learn from failure	Use human senses to gather information

# Database of OpenSTEM Labs activities



The screenshot shows an Excel spreadsheet with the following content:

**1 DRAFT Database of OpenSTEM Labs activities**

**3 Name of person completing form:**

**5 Guidance:**

6 Use the drop down menus to select the appropriate category for each answer.

7 Each learning outcome/ objective has a detailed description (see note by clicking on the small red triangle in the corner of the cell)

9	Equipment Name					
10	Activity Name					
11	Module Reference					
12	<b>Experiment Classification based on items in 'Figure for eSTeEM Project.pptx'</b>					
13	Experiment Type					
14	Remote Interaction Type					
15	Online interaction Type					
16	Experimenter					
17	Experiment Design	Context (how life-like)				
18		Learning type				
19		Interaction type				
20	Experiment support	Pre-lab support				
21		Pre-requisites				
22	Experiment access	Access type				
23		In-lab support				
24	<b>Experiment mapping adapted from Feisel &amp; Rosa (2005) Fundamental Objectives of Engineering Instructional Laboratories and incorporating some content from Brinson (2015)</b>					
25	<b>"By completing the laboratories in the engineering undergraduate program, you will be able to ..."</b>					
26		Knowledge and Understanding				
27		Instrumentation				
28		Models				
29		Experiment				
30		Data Analysis				
31		Design				
32		Learn from Failure				
33		Creativity				
34		Psychomotor				

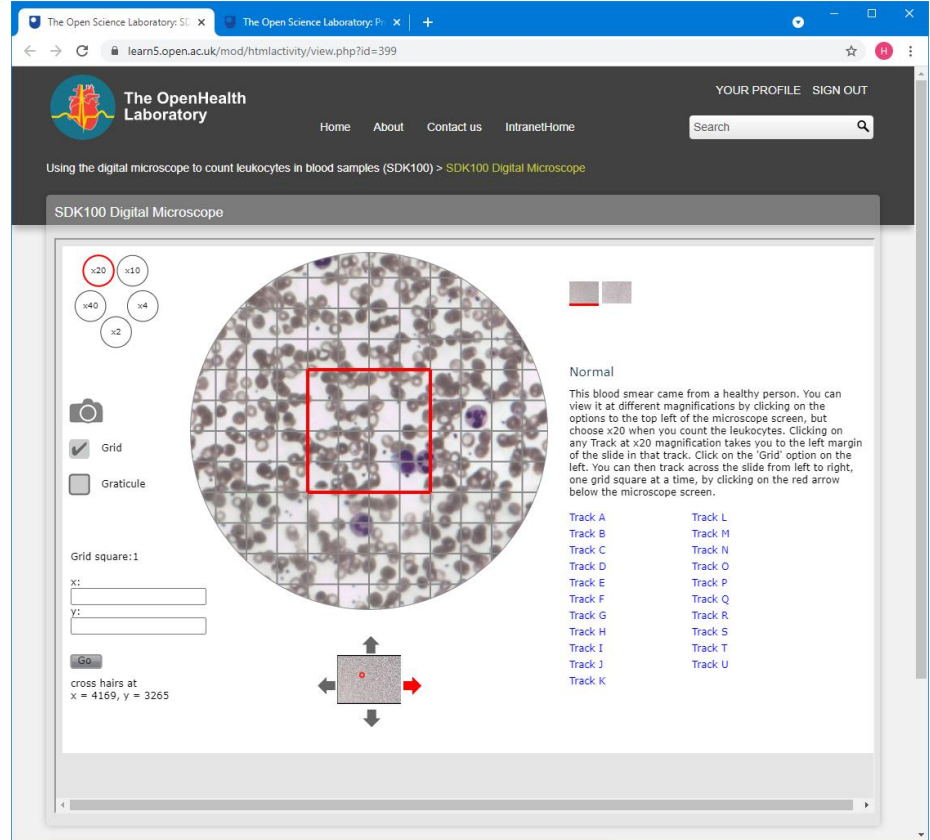
# Trial Classification – Using the digital microscope to count leukocytes in blood samples (SDK100)

## Experiment Classification (examples)

Experiment Type	Virtual
Interaction type	Stored dataset
Learning type	Directed
Access type	Open

## Learning Objectives (examples)

- Apply appropriate instrumentation
- Devise experimental approach
- Collect and analyse data
- Communicate effectively
- Use human senses to gather information



The screenshot shows a web browser window displaying the 'SDK100 Digital Microscope' interface. The page header includes 'The OpenHealth Laboratory' logo and navigation links (Home, About, Contact us, Intranet-Home). A search bar is present. The main content area features a large circular microscope view of a blood smear with a red grid overlay. To the left of the view are magnification options (x20, x10, x40, x4, x2) and checkboxes for 'Grid' (checked) and 'Graticule'. Below the view are input fields for 'Grid square:1', 'X:', and 'Y:', and a 'GO' button. A status bar at the bottom indicates 'cross hairs at x = 4169, y = 3265'. On the right side, there is a 'Normal' section with a paragraph of text and a list of tracks (Track A through Track U).

# Trial Classification – Investigating strain in a thick-walled pressure vessel (T272)

## Experiment Classification (examples)

Experiment Type	Remote
Interaction type	Experiment
Learning type	Directed
Access type	Bookable

## Learning Objectives (examples)

- Apply appropriate instrumentation
- Use theoretical models
- Collect and analyse data
- Identify health and safety issues
- Use human senses to gather information



The screenshot displays the 'Pressure Vessel' software interface. It features a sidebar with navigation options: Experiment video, Pressure gauge video, Controls, and Data. The main area is divided into four panels:

- Experiment video:** Shows a photograph of the 'SMART THICK CYLINDER' experimental setup.
- Pressure gauge video:** Shows a close-up of a pressure gauge with a scale from 0 to 10 MN/m<sup>2</sup>.
- controls:** Includes a 'Motor power' gauge set to 40%, a 'Zeroise readings' button, and 'Rev' and 'Fwd' buttons.
- Data:** Displays a circular strain gauge layout with 13 gauges labeled R1 through R13. A legend identifies the gauge types: Radial (green), Hoop (blue), Circumferential (orange), and Longitudinal (pink). To the right, a table shows strain values in units of  $\times 10^{-5}$ .

Strain ( $\times 10^{-5}$ )	Value
1	47
2	-54
3	9
4	-8
5	-28
6	19
7	-16
8	-12
9	9
10	-8
11	103
12	0
13	7

- Literature review has helped us to understand the types of remote and onscreen experiments used in Science and Engineering and their learning objectives
- A classification scheme for OpenSTEM Labs activities has been developed
- Initial trials of the classification scheme show how it could help module teams to identify existing OpenSTEM Labs activities for reuse or adaptation to other modules
- Results provide a starting point for a design tool to help module teams developing future OpenSTEM Labs activities

We welcome your feedback!

# Questions?

1. Feisel, L. D. and Rosa, A. J. (2005) 'The Role of the Laboratory in Undergraduate Engineering Education', *Journal of Engineering Education*, 94(1), pp. 121–130.
2. Brinson, J.R. (2015) Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research. *Computers and Education*, (87), pp. 218–237.
3. Nickerson, J.V., Corter, J.E., Esche, S.K. and Chassapis, C., 2007. A model for evaluating the effectiveness of remote engineering laboratories and simulations in education. *Computers & Education*, 49(3), pp. 708-725.
4. Zutin D.G., Auer M.E., Maier C., and Niederstatter M., "Lab2go – A repository to locate educational online laboratories," in Proc. of IEEE EDUCON 2010 Conference: The Future of Global Learning Engineering Education, Madrid, Spain, 14-16 April 2010, IEEE, pp. 1741-1746.