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A classification scheme for OpenSTEM Labs experiments

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ESTEEM
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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

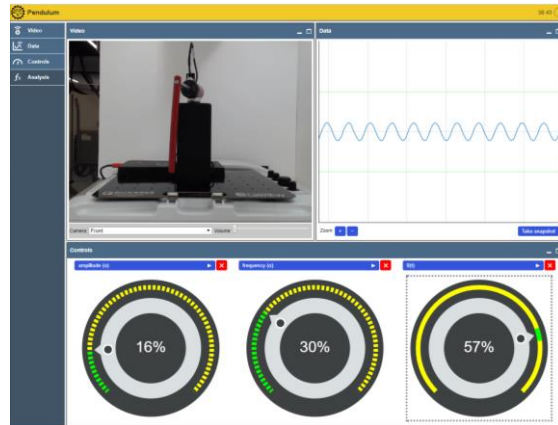
- The OpenSTEM Labs deliver authentic practical experiences to the Open University's distance learning students using real time instrumentation, data and equipment for practical enquiries over the internet
- Students interact with experiments via a web browser on their laptop or mobile device.
- The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



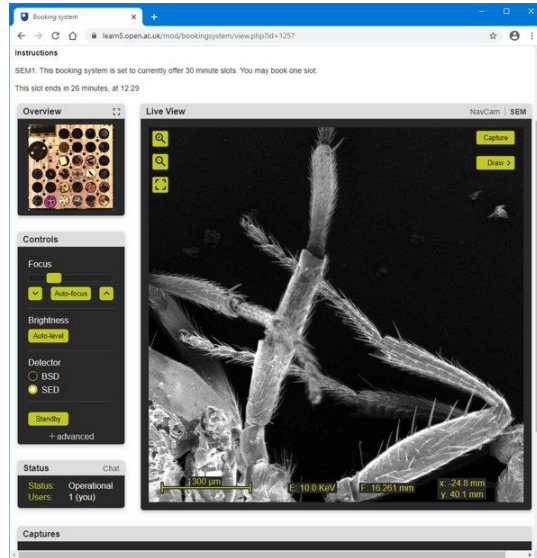
Example OpenSTEM Labs activities



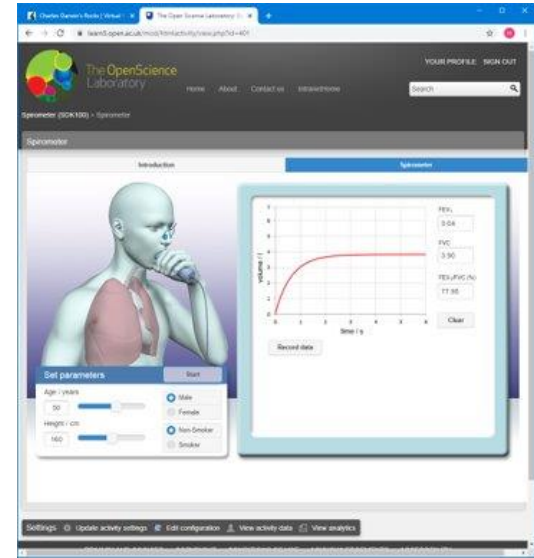
OpenScience Observatories



Controlling a driven pendulum



Scanning Electron Microscope



Spirometer

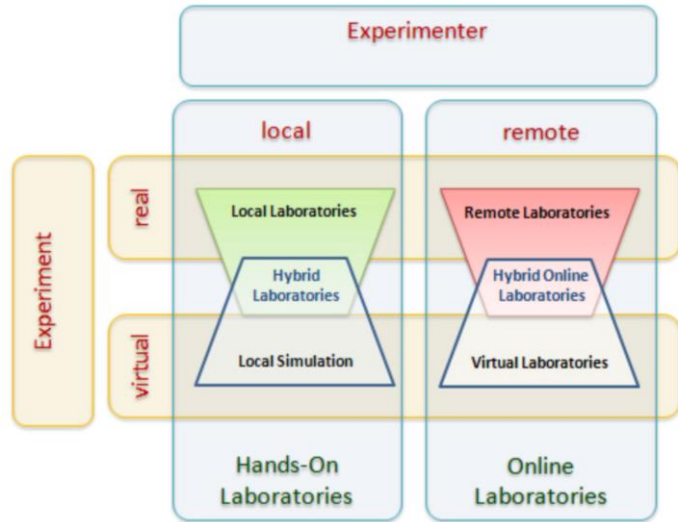
Aim:

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.

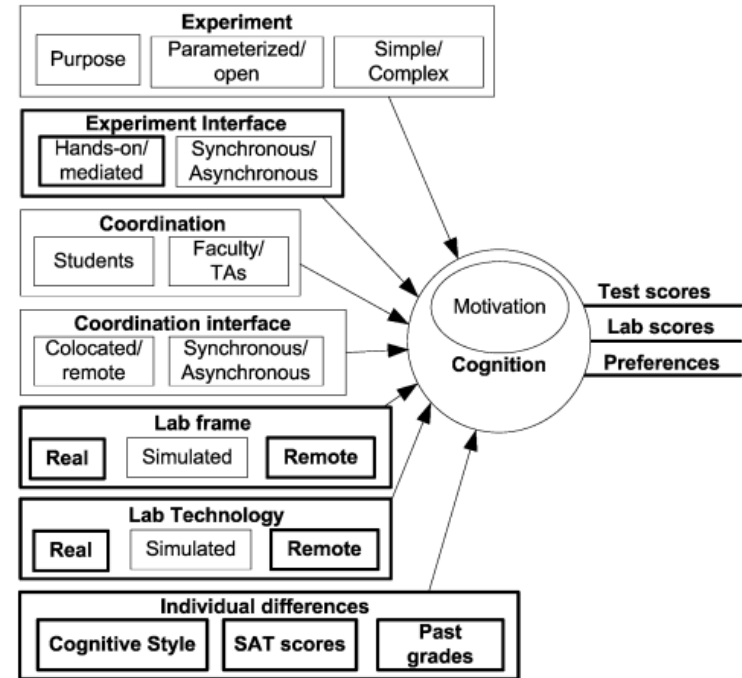
Objectives:

- 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

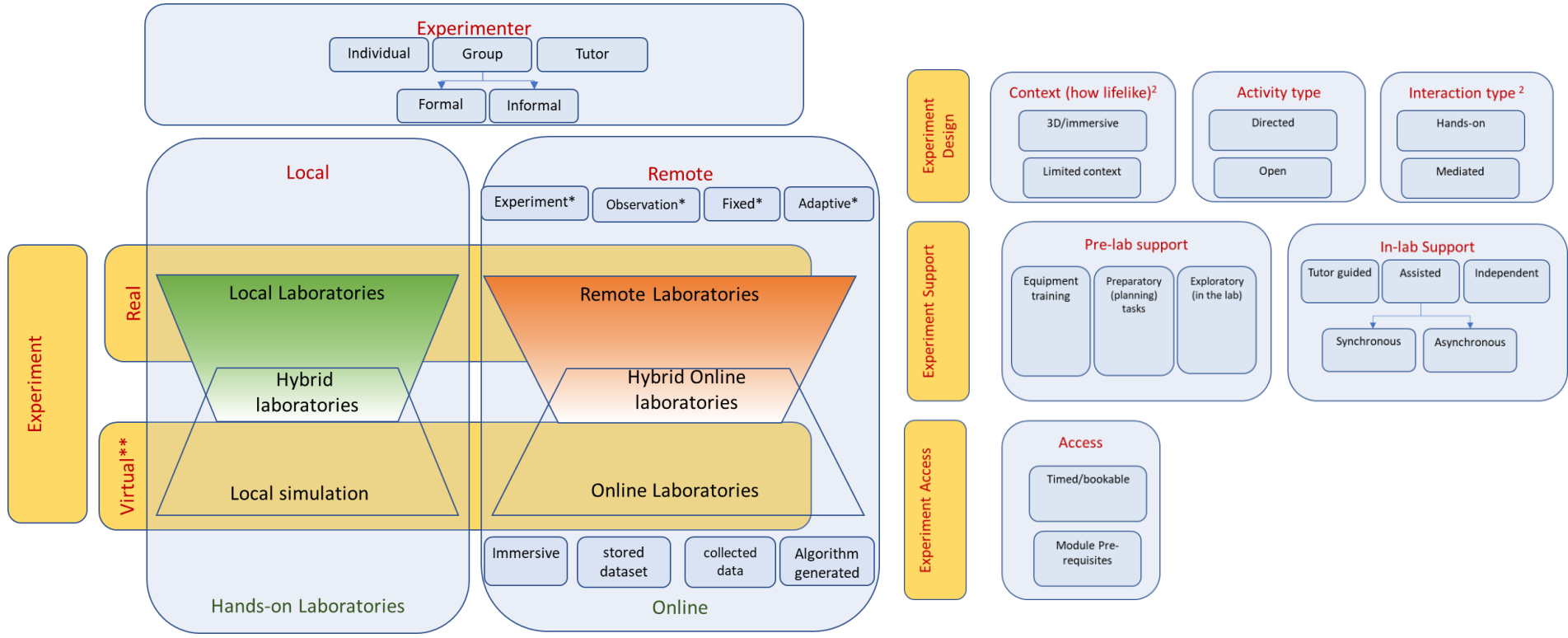
Learn from Failure

Sensory Awareness

Creativity

Feisel & Rosa (2005)

Proposed classification scheme for OpenSTEM Labs activities

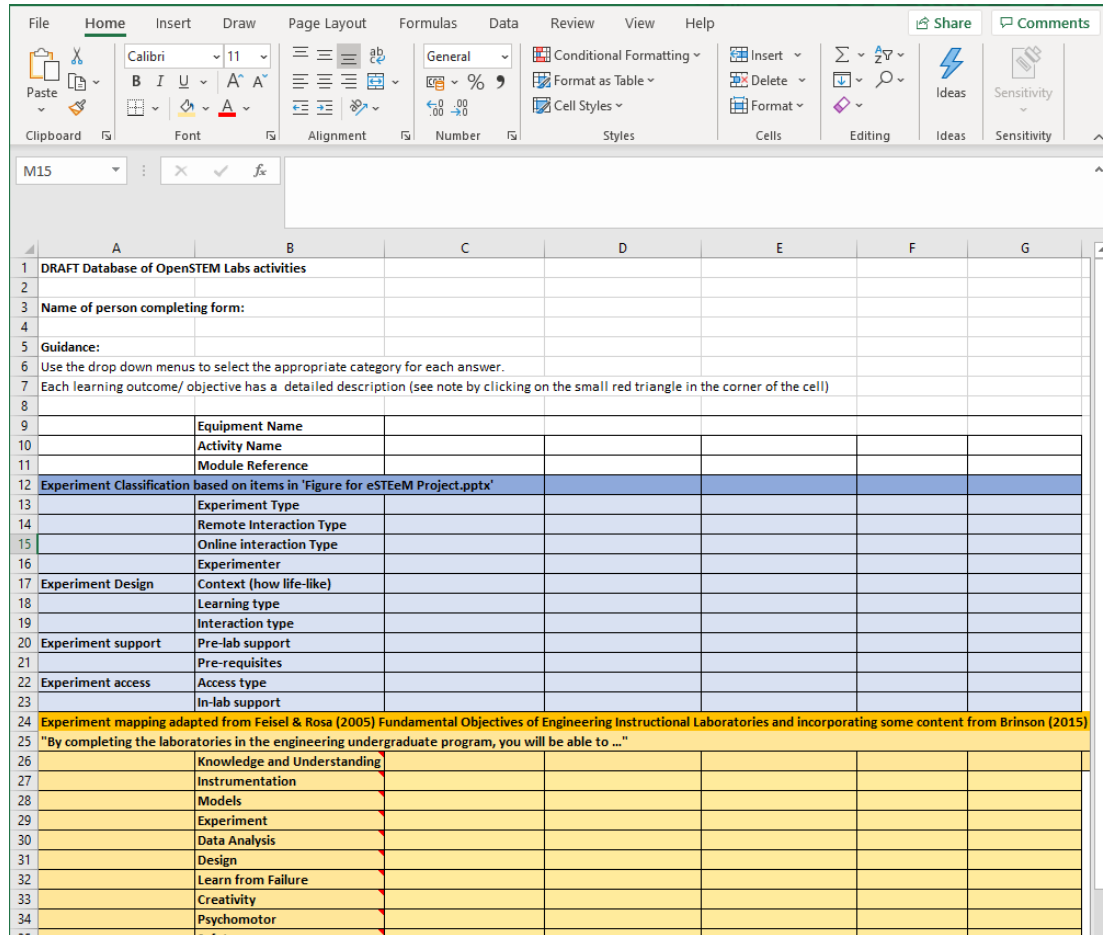


Developed based on Zutin et al. (2010) and others

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 a Microsoft Excel spreadsheet with the following content:

- Row 1:** DRAFT Database of OpenSTEM Labs activities
- Row 3:** Name of person completing form:
- Row 5:** Guidance:
- Row 6:** Use the drop down menus to select the appropriate category for each answer.
- Row 7:** Each learning outcome/ objective has a detailed description (see note by clicking on the small red triangle in the corner of the cell)
- Table (Rows 9-23):**

	Equipment Name					
	Activity Name					
	Module Reference					
Experiment Classification	based on items in 'Figure for eSTeEM Project.pptx'					
	Experiment Type					
	Remote Interaction Type					
	Online interaction Type					
	Experimenter					
Experiment Design	Context (how life-like)					
	Learning type					
	Interaction type					
Experiment support	Pre-lab support					
	Pre-requisites					
Experiment access	Access type					
	In-lab support					
- Row 24:** Experiment mapping adapted from Feisel & Rosa (2005) Fundamental Objectives of Engineering Instructional Laboratories and incorporating some content from Brinson (2015)
- Row 25:** "By completing the laboratories in the engineering undergraduate program, you will be able to ..."
- Table (Rows 26-34):**

	Knowledge and Understanding					
	Instrumentation					
	Models					
	Experiment					
	Data Analysis					
	Design					
	Learn from Failure					
	Creativity					
	Psychomotor					

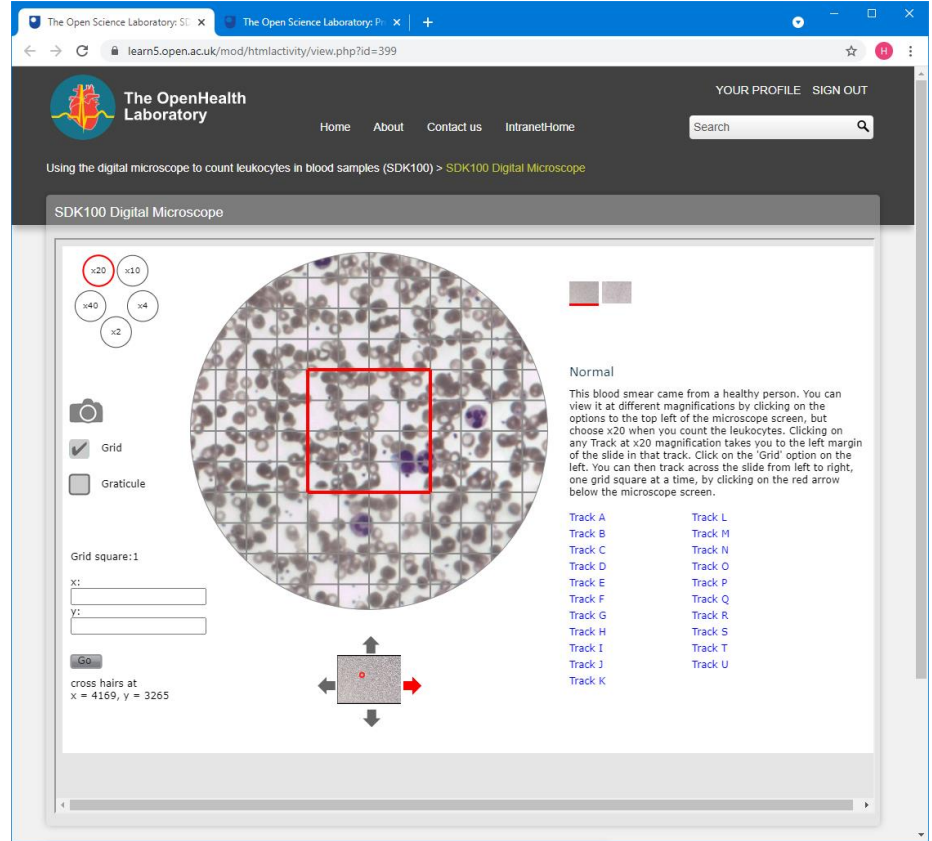
Trial Classification – Using the digital microscope to count leukocytes in blood samples (SDK100)

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 displays the 'SDK100 Digital Microscope' web application. The main interface features a circular microscope view of a blood smear with a grid overlay. A red square highlights a specific area. On the left, there are magnification options (x20, x10, x40, x4, x2) and checkboxes for 'Grid' (checked) and 'Graticule'. Below the microscope view, there are input fields for 'Grid square:1', 'X:', and 'Y:', and a 'GO' button. At the bottom, it shows 'cross hairs at x = 4169, y = 3265'. On the right, there is a 'Normal' section with text explaining the application 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 'T272 SMART THICK CYLINDER' experimental setup.
- Pressure gauge video:** Shows a close-up of a pressure gauge with a scale from 0 to 10 MN/m².
- controls:** Includes a 'Motor power' gauge set to 40%, a 'Zeroise readings' button, and 'Rev' and 'Fwd' buttons.
- Data:** Displays a circular diagram of the vessel with 13 strain gauges (R1-R13) and a table of strain values (× 10⁻⁵).

Strain (× 10 ⁻⁵)	Strain (× 10 ⁻⁵)
1 47	7 13
2 -54	8 -12
3 9	9 9
4 -8	10 -8
5 -28	11 103
6 19	12 0
	13 7

Strain Gauges
 ■ Radial
 ■ Hoop
 ■ Circumferential
 ■ Longitudinal

Radii in mm

- 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.