The Practical Engineering Education Conference 2026

2 & 3 July 2026, The University of Edinburgh, Edinburgh UK

Booklet of the Practical Engineering Education Conference 2026

Curriculum Transformation, Student-Teacher Interactions, Problem- Project- Scenarios-Based Learning, Transformative Assessments and Digitalisation and AI

Organised by the School of Engineering at the University of Edinburgh

The Nucleus Building at the University of Edinburgh, 2 & 3 July 2026, UK

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WELCOME

Welcome to the 4th Practical Engineering Education Conference (PEE24), hosted at the Diamond Building, University of Sheffield, from July 2nd to 3rd, 2024. This booklet contains all the abstracts accepted for presentation at the conference.

All engineering is practical and it is of paramount importance for the development and formation of the future graduates and engineers of the future. Practical Engineering allows students to understand and apply in a practical manner the theoretical and fundamental concepts seen in other concomitant Engineering Courses. We define practical engineering education as hands-on teaching that typically occurs in laboratories and workshops, where students conduct experiments and fabricate artefacts and are allowed to play.

Hence, PEE26 is a conference focused on the hands-on learning that happens in workshops and labs. While engineering is full of theoretical concepts, the real challenge is making things work in the real world. Often, the excitement of learning gets lost in static equations. Practical engineering education bridges this gap, where theory meets reality.

This conference is more than a showcase; it aims to revolutionise engineering education. Join us to:

- Discover and share innovative teaching methods.
- Engage with others who are passionate about hands-on learning.
- Help build a curriculum that fosters a love for real-world engineering.

Let's transform theory into practice. PEE26 awaits your engineering ideas!

HISTORY OF CONFERENCE

In September 2021 the University of Sheffield hosted the first-ever Practical Engineering Education conference, PEE21, welcoming delegates from more than 20 Universities from UK and Ireland and sponsors from 4 of the UK's leading equipment suppliers, link here. The second PEE conference in 2022 in conjunction with Sheffield Hallam University in 2022, PEE22. Following overwhelmingly positive feedback and interest from the event, the third PEE conference was hosted again at the University of Sheffield in 2024, PEE24.

It is now time for the Practical Engineering Education Conference to be hosted in the beautiful city of Edinburgh, coined as CNN Travel number one best city in the world in 2022.

Edinburgh and The University of Edinburgh have homed a great number of renowned Scottish engineers and scientists such as James Clerk Maxwell, Robert Stirling, William John Macquorn Rankine, and Joseph Black fathers of the classical theory of electromagnetic radiation, the Stirling engine, the first and third law of thermodynamics, and the latent heat and specific heat, respectively, principles and concepts of very much relevance to phase-change, heat and mass transfer, and steam cycles, amongst others, which we teach and make use in Practical Engineering Education.

Daniel Orejón

Daniel Orejon

PEE26 Conference Chair

CONFERENCE THEMES

The main theme of the conference is:

Curriculum Transformation, Student-Teacher Interactions, Problem- Project- Scenarios-Based Learning, Transformative Assessments and Digitalisation and AI

The specific Themes and their subsets are:

Engineering practice in Higher Education and Curriculum Transformation Programme

- Curriculum co-creation including students' voices
- Students as Practical Engineering Educators
- In-house design and build of practical education equipment in line with fundamental and applied research in the taught curriculum integration
- United Nations Sustainability Development Goals within the curriculum

Student-teacher practical engineering interactions

- Inclusivity and accessibility in the practical curriculum
- Investigating student-teacher practical interactions and emotions both in-person, online and in hybrid settings
- Diversity Equity, and Inclusion DEI in practical education
- Dedicated mentoring circles that ease inclusivity and accessibility
- Student-led societies contributing to practical engineering

Digitalisation and Artificial Intelligence in practical engineering higher education

- Developing artificial intelligence AI tutors supporting practical settings
- Beyond the traditional practical pedagogy with novel digital & hybrid approaches
- Bringing digitalisation into in-person laboratories
- Sharing remote practical labs between universities
- The in-person, the hybrid and the remote
- AI/ChatGPT/ChatBox Tutor Assistants
- Digital tools, remote labs, AI and other resources to combat universities potential financial climate

Problem-, Project- & Scenario-Based Learning

- Breadth and choice of students' practical hands-on experience and design
- Industrial participation/integration in the practical hands-on experience design
- Aligning in-person and online pre-/post-preparation work
- Student led Problem-, Project- & Scenario-Based Learning

Transformative assessment & practical work feedback

- Authentic assessment and feedback literacy
- Innovation and technical opportunities for assessment and feedback in practical settings
- Peer feedback in practical engineering and peer contribution assessment
- Automating feedback from digitally-mediated interactions
- Measuring the effectiveness of the lab reports skills and assessment
- Large Language Models to improve feedback on lab reports

CONFERENCE ORGANISING COMMITTEE

Name	Role	Institution	PEE Role
Prof. Guangzhao Mao	Head of Engineering School	UoE	Local Organiser
Prof. Dave Laurenson	Director of Learning & Teaching	UoE	Local Organiser
Prof. Tim Drysdale	Chair of Technology Science Education	UoE	Local Organiser
Prof. Tim Stratford	Former Dean of Learning & Teaching	UoE	Local Organiser
Prof. Prashant Valluri	Director of Chemical Engineering Discipline	UoE	Local Organiser
Dr. Ignacio Tudela-Montes	Deputy Director Learning & Teaching & Chemical Engineering Lab Manager	UoE	Local Organiser
Dr. Daniel Orejon	Former Chemical Engineering Lab Manager	UoE	Local Organiser & Chair
Dr. Amer Syed	Discipline Manager Mechanical Engineering & MakerSpace Manager	UoE	Local Organiser
Dr. David Reid	Remote Labs Experimental Officer	UoE	Local Organiser
Mr. Andrew Brown	Remote Labs Technical Officer	UoE	Local Organiser
Ms. Isis Ingram	Chemical Engineering Lab Technical Officer	UoE	Local Organiser
Ms. Laura Smith	Research Institute Services Supervisor	UoE	Local Organiser
Miss Karen Brocklehurst	Research Institute Services Admin	UoE	Local Organiser
Miss Kimberly Ross	Research Institute Services Supervisor	UoE	Local Organiser
Dr. Tushar Srivastava	PDRA in Laser Diagnostics	UoE	Local Organiser
Miss Janice To	PHD Institute Multiscale Thermofluids	UoE	Local Organiser
Mr. Jiexi Li	UG Chemical Engineering Student		Local Organiser
Dr. Chalak Omar	Senior University Teacher Multidisciplinary Eng Education	University of Sheffield	External Organiser & Chair
Prof. Andrew Garrard	Head Multidisciplinary Eng Education	University of Sheffield	External Organiser
Ms. Emma Kenny-Levick	Senior Administration Officer	University of Sheffield	External Organiser

KEYNOTE SPEAKERS – PROFESSOR ANDREW GARRARD

Professor Andrew Garrard

Professor of Engineering Education & Head of Multidisciplinary Engineering Education

https://sheffield.ac.uk/engineering/diamond-engineering/our-staff/andrew-garrard

Experiments under the microscope: Why do we teach lab classes and do they have a place in a world with AI?

Abstract:

If you were to ask engineering academics whether they thought it was important to include lab classes in a degree programme, there would likely be overwhelming agreement that it was. If you were to dig a little deeper and ask why they thought labs were so important, you would receive a multitude of different justifications. In this talk, we explore the history of practical engineering education, the seminal publications on the subject, and the predominantly cited expected learning outcomes from labs. The Covid-19 pandemic provided the ultimate empirical test of the justification for the continued delivery of the contemporary engineering lab class by removing learners' access to physical experimental equipment. Despite the ubiquity of the uninvited disruption and the realisation of the efficiency gains achievable with remote learning, as Covid restrictions were lifted, the business of teaching engineering labs (mostly) reverted to the same traditional formats that have been employed for decades. Is this due to academics' clichéd resistance to change or a case of "if it ain't broke, don't fix it"? This question can be answered by considering the universally agreed importance of lab classes in an engineering curriculum and what students gain from the experiences of working together, investigating the phenomena of the natural world. This also provides a model to predict the relevance of the practical lab class in a world where AI will be increasingly dominant in higher education, where HE is under increasingly constrained funding, and where big data reduces the need for engineers to understand the nature of complex systems.

Biography:

Andrew Garrard is a Professor of Engineering Education. He cut his teeth in teaching as a senior lecturer at Sheffield Hallam University in 2009 before taking up a role at the University of Sheffield to help deliver the ambitious new teaching-focused engineering building, the Diamond. The building houses multidisciplinary teaching labs, and Andrew is the head of a group of 50 staff who work in those labs and are focused entirely on practical education. Andrew has been called upon for his expertise in practical engineering teaching at scale and started the Practical Engineering Education Conference in 2021.

If you want to learn more about Andrew please check:

https://sheffield.ac.uk/engineering/diamond-engineering/our-staff/andrew-garrard

KEYNOTE SPEAKERS – PROFESSOR RAFFAELLA OCONE

Professor Raffaella Ocone

Professor Outcome-Based Education in Geoscience, Infrastructure and Society

President of the Institution for Chemical Engineers

https://www.hw.ac.uk/profiles/uk/school/egis/faculty/raffaella-ocone
https://rse.org.uk/whats-on/exhibition/women-science-exhibition/professor-raffaella-ocone/
https://www.icheme.org/about-us/strategy-and-leadership/board-of-trustees/raffaella-ocone/

The role of Engineering Education and IChemE on shaping Engineering Future Skills

Abstract:

The energy transition presents a once-in-a-century opportunity to engineer a more sustainable world. Meeting this challenge will require not only technological innovation, but also the development of new skills for the next generation of engineers.

This talk will explore the skills that will shape the future of chemical engineering, drawing on work undertaken during Institution of Chemical Engineers (IChemE) presidency, including insights from surveys, roundtable discussions, and the presidential inquiry launched last month into the state of chemical engineering research.

The findings highlight both the uncertainty surrounding the skills likely to be in greatest demand over the coming decade and the clear consensus on the growing importance of problem-solving, critical thinking, communication, adaptability, systems thinking and practice. Future engineers will need to work effectively across disciplinary and organisational boundaries, requiring a broader and more integrated skill set than ever before.

Universities and professional bodies therefore have a vital role to play in embedding these capabilities within education and professional development programmes, helping to shape and support the profession through this rapidly evolving transition.

Biography:

Raffaella Ocone OBE FREng FRSE studied chemical engineering at the University of Naples Federico II before completing her MA and PhD at Princeton University. She holds a degree honoris causa from the University of Surrey.

Since 1999, Raffaella has been Professor of Chemical Engineering at Heriot-Watt University, becoming the first woman to hold a chair in chemical engineering in Scotland. Her research advances the modelling of complex reactive and multiphase systems, supporting innovations in carbon capture, sustainable hydrogen production, and other technologies critical to the energy transition.

In 2017, she became the first Caroline Herschel Visiting Professor in Engineering at Ruhr University, in recognition of her contributions to engineering ethics; the same year she was appointed Cavaliere of the Order of the Star of Italian Solidarity by the President of the Italian Republic. In 2019, she was appointed Officer of the Order of the British Empire (OBE) for services to engineering and was named one of the Top 100 Most Influential Women in Engineering. In 2025, she became the 84th President of the Institution of Chemical Engineers (IChemE). In 2026 she was elected to the prestigious Accademia Nazionale delle Scienze detta dei XL (Italian National Academy of Sciences).

Beyond her research, Raffaella is a strong advocate for ethics in engineering and for increasing diversity and inclusion in STEM, particularly encouraging more women to pursue engineering careers.

If you want to learn more about Raffaella please check:

https://researchportal.hw.ac.uk/en/persons/raffaella-ocone/

KEYNOTE SPEAKERS – PROFESSOR TIM DRYSDALE

Professor Tim Drysdale

Chair in Technology Enhanced Science Education

https://eng.ed.ac.uk/about/people/professor-timothy-drysdale

Near-Future Practical Work - Digitisation, Industry and Student Experience

Abstract:

The intersection of external developments in artificial intelligence, industry practice and higher education sector finances make for challenging times in engineering education. They also invite optimism about changes that not only future proof our approaches but also address latent issues. At the heart of the issue is the increasing digitalisation of engineering, brought about initially by the development of electronic control systems, then digital computers, then high-bandwidth low-latency networking which allows for remote operation. Adjusting to operating in a hands-off environment is non-trivial, and in my view, requires addressing explicitly in our curriculum. Further, our increasingly constrained resources and growing student numbers have constrained many to cook-book laboratories, often with strict time pressure. Much of the work is then done unsupervised, to produce a laboratory report. With the widespread emergence of generative artificial intelligence, I argue that focusing on written proxies for engineering behaviour is no longer sufficient. Instead, we should directly analyse engineering activity and seek engineering behaviours, such as iterative improvement. This is not possible in a cost effective manner using traditional in-person teaching methods, but becomes practical at scale when digital data streams are available, such as from data flowing between students and remote laboratories. Linking these behaviours to the requirements of industry is a further challenge, because of the diversity of requirements that future employers have. However, we can do well to be informed of characteristics that apply more generally, and I will discuss two different existing sources of this information and speculate about how we might go about integrating it into the practical work of the near future.

Biography:

Timothy D. Drysdale received the B.E. (1st Class Hons., University Prize) and Ph.D. degrees in Electrical and Electronic Engineering from the University of Canterbury, Christchurch, New Zealand, in 1999 and 2004, respectively. From 2002 -- 2005 he was a Post-Doctoral Research Associate in the Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow, U.K, and from 2005 -- 2006 a Scottish Executive / Royal Society of Edinburgh Personal Research Fellow in the same. From 2006 -- 2015 he was a Lecturer in the Electronics Design Centre at the University of Glasgow.

From 2015-2018, he was a Senior Lecturer in Engineering at the Open University, Milton Keynes, U.K. where he was the Founding Director and Lead Developer of the Open Engineering Laboratory which was recognised by awards including the Times Higher Education Outstanding Digital Innovation 2017, The Guardian Teaching Excellence 2018, Global Online Labs Consortium Remote Experiment Award 2018, National Instruments Global Engineering Impact Award for Education 2018, and a Queen's Anniversary Prize in 2023.

Since 2018 he has been the Chair of Technology Enhanced Science Education in the School of Engineering, where he currently also holds the role of Director of Strategic Digital Education. He is the founder of the Practable.io remote laboratory system which won the Association for Learning Technology/ Jisc Digital Transformation Award in 2023 and Global Online Labs Consortium Remote Experiment Award in 2024. He is an Associate Editor of IET Microwave Antennas and Propagation, Senior Fellow of the Higher Education Academy, and his public engagement work has included the Royal Society Summer Science Exhibition, Science Day at Buckingham Palace, and the Isambard Kingdom Brunel Award Lecture at the British Science Festival.

If you want to learn more about Raffaella please check:

https://eng.ed.ac.uk/about/people/professor-timothy-drysdale

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GUNT TECHNOLOGY LIMITED	**Gunt Technology** https://www.gunt-technology.co.uk/ Through their headquarters in Hamburg and UK office in Hampshire, GUNT engineers develop, manufacture, and supply didactic equipment that is designed specifically for teaching in universities, colleges, technical and vocational schools. This gives students a hands-on practical approach to help understand even the most complex principles. In addition to its broad range of equipment, GUNT has developed innovative tutorial software and web-based E-learning modules, these form a comprehensive range of teaching materials and videos to assist both student and teacher. Combined with augmented reality, digital acquisition of test results and network capability, multiple users can access real-time data, all of which are designed to complement GUNT's product range and to meet Industry 4.0 criteria.
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	Feedback & Leybold https://www.feedback-instruments.com We enable educational institutions to effectuate the transformation of theoretical knowledge into comprehensive engineering competencies through the implementation of innovative, hands-on, scenario-based laboratory systems. Our systems incorporate precisely structured,

	scenario-driven experiments with sophisticated and realistic setups that faithfully simulate real-world engineering applications across electrical, automotive, and scientific fields. —enhancing student comprehension, fostering enduring confidence, and producing graduates who are thoroughly prepared to meet the demands of the industry. Our vision, fostered through a strategic partnership with LD Didactic GmbH, is to design and deliver advanced laboratory-based instructional systems that revolutionize experiential learning within the realm of engineering education. We address a fundamental challenge in contemporary pedagogy by equipping students with the ability to translate theoretical concepts into practical skills with accuracy and support educators in cultivating dynamic, immersive learning environments. We are a world-leading engineering company, building on a legacy of innovation to advance global solutions through transformative research, education, and civic engagement.
	Mechatronics https://www.mech.co.uk/index.htm MECHATRONICS International Ltd is a family run, customer orientated company, established in 1988 to assist in training and re-skilling engineers. As a proud British manufacturer and leading supplier of trusted, reliable, high-quality, cost-effective training equipment covering the areas of: - Pneumatics, Hydraulics, P.L.C., Mechanical Transmission, Automation and Robotics. The extensive range is all based on 'genuine' industrial products and applications, covering School, College, University and Industrial level training requirements. The extensive range of training equipment and supporting range of courseware and teachware is all based on 'genuine' industrial products and applications, covering School, College, University and Industrial level training requirements. In addition to our standard range of products we often undertake commissions to build specials and one-off systems.
	Ossila https://www.ossila.com/ Ossila empowers researchers with trusted equipment, established and cutting-edge materials, and essential lab supplies at accessible prices. Backed by decades of academic experience, Ossila products are efficient and precision-engineered, enabling transformative discoveries around the world. Popular Ossila products include the spectrophotometer and the USB spectrometer. The latest piece of spectroscopy equipment from the company is the spectrofluorometer, which enables accurate measure of absorption, transmission, and fluorescence emission and excitation for optical characterisation.

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practable.io(TM)	**Practicalbe.io** https://practable.io/ Bring experimentation and data skills into the classroom with online laboratories. Practable.io uses large class sets of equipment to let students make real-time measurements for timetabled and independent use, supported with instant formative feedback and progress dashboards for students and staff.
ENGINEERING FOR CHANGE	**Engineering for Change** https://www.eusa.ed.ac.uk/activities/view/engineeringforchange *Engineering for Change* (*E4C*) is a society in which you can get involved in a wide range of projects. Our overall goal is to put the power in your hands to change the world for the better. We do so by using STEM to develop solutions to sustainability and humanitarian development issues through local and international projects.

PROGRAMME AT GLANCE DAY 1

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<tr><td>8:30-9:30</td><td colspan="3">Registration, Breakfast/Coffee, Networking Sessions, Sponsors' Interactions</td><td>Nucleus Ground Floor</td></tr>
<tr><td>9:30-9:45</td><td colspan="3">House Keeping and Opening Address: Professor Guangzhao Mao
Head of School of Engineering, University of Edinburgh</td><td>Larch lecture theatre</td></tr>
<tr><td>9:45-10:15</td><td colspan="3">Keynote Talk 1
Professor Andrew Garrard
Experiments under the microscope: Why do we teach lab classes and do they have a place in a world with AI?</td><td>Larch lecture theatre</td></tr>
<tr><td>10:15-10:30</td><td colspan="3">Sponsors TecQuipment</td><td rowspan="2">Larch lecture theatre</td></tr>
<tr><td>10:30-10:45</td><td colspan="3">Sponsors Gunt Technology</td></tr>
<tr><td>10:45-11:15</td><td colspan="3">Coffee Break, Networking Sessions, Sponsors' Interactions and Posters</td><td>Alder Lecture Theatre</td></tr>
<tr><th>TIME</th><th>EVENT</th><th>LOCATION</th><th>EVENT</th><th>LOCATION</th></tr>
<tr><td>11:15-12:30</td><td>Parallel Session 1 - Eng Practical HE Curriculum Transformation (x5)</td><td>Larch lecture theatre</td><td>Parallel Session 2 - Students Teacher Interactions (x5)</td><td>Rowan studio</td></tr>
<tr><td>12:30-13:30</td><td colspan="3">Lunch & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters</td><td>Alder Lecture Theatre</td></tr>
<tr><td>13:30-14:05</td><td colspan="3">Keynote Talk 2
Professor Raffaella Ocone
The Role of IChemE and Accreditation Institutions in Practical Engineering Education</td><td>Larch lecture theatre</td></tr>
<tr><th>TIME</th><th>EVENT</th><th>LOCATION</th><th>EVENT</th><th>LOCATION</th></tr>
<tr><td>14:05-14:45</td><td>Workshop 1 (x1)</td><td>Larch lecture theatre</td><td>Workshop 2 (x1)</td><td>Rowan studio</td></tr>
<tr><th>TIME</th><th colspan="3">EVENT</th><th>LOCATION</th></tr>
<tr><td>14:45-15:00</td><td colspan="3">Sponsors Feedback</td><td rowspan="2">Larch lecture theatre</td></tr>
<tr><td>15:00-15:15</td><td colspan="3">Sponsors Didactic Services DSL</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">Poster Presentations Pitches - 3 mins each - Problem, Solution, Impact (x10)</td><td>Larch lecture theatre</td></tr>
<tr><td>15:30-16:15</td><td colspan="3">Coffee Break, Networking Sessions, Sponsors' Interactions and Posters</td><td>Alder Lecture Theatre</td></tr>
<tr><td>15:30-16:15</td><td colspan="3">Demonstration Session 1 (x3)</td><td>Alder Lecture Theatre</td></tr>
<tr><td>16:15-17:00</td><td colspan="3">Debate/Discussion Panel (x1)</td><td>Larch lecture theatre</td></tr>
<tr><td>17:00-17:00</td><td colspan="3">Time Off</td><td>Around Campus</td></tr>
<tr><td>19:00-23:00</td><td colspan="3">Gala Dinner</td><td>In City Centre TBC</td></tr>
</table>

PROGRAMME AT GLANCE DAY 2

PEE26 PRGORAMME - DAY 2

TIME	EVENT	LOCATION	EVENT	LOCATION
8:30-9:00	Registration, Breakfast/Coffee, Networking Sessions, Sponsors' Interactions			Nucleus Ground Floor
9:00-9:30	Keynote Talk 3 Professor Tim Drysdale Near-Future Practical Work - Digitisation, Industry and Student Experience			Larch lecture theatre
9:30-9:45	Sponsors Quanser			Larch lecture theatre
9:45-10:00	Sponsors Autodesk			
10:00-10:15	Sponsors Mechatronics			
10:15-10:30	Sponsors SMC			
10:15-10:45	Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
	EVENT	LOCATION	EVENT	LOCATION
10:45-12:15	Parallel Session 3 - Problem Project Scenario Based Learning	Larch lecture theatre	Parallel Session 4 - Transformative Assessment + Digitalisation AI in PEE	Rowan studio
12:15-13:15	Lunch & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
	EVENT	LOCATION	EVENT	LOCATION
13:15-14:15	Classroom Demonstration 1 (x2)	Larch lecture theatre	Classroom Demonstration 2 (x2)	Rowan studio
	EVENT	LOCATION	EVENT	LOCATION
14:15-15:45	Classroom Demonstration 3 (x3)	Larch lecture theatre	Workshop 3 (x1)	Rowan studio
15:45-16:55	Sponsors Engineering For Change			Larch lecture theatre
15:55-16:45	Demonstration Sessions & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
15:55-16:45	Demonstration Sessions 2 (x4)			Alder Lecture Theatre
16:45-17:00	Concluding Remarks			Larch lecture theatre
17:00-18:00	Lab Visits AND/OR Departure			Around Campus

PROGRAMME DAY 1

PEE26 PROGRAM - DAY 1				
TIME	**EVENT**			**LOC.**
8:30-9:30	**Registration, Breakfast/Coffee, Networking Sessions, Sponsors' Interactions**			**Nucleus GFr**
9:30-9:45	House Keeping and Opening Address: **Professor Guangzhao Mao**, Head of School of Engineering, University of Edinburgh **Dr Daniel Orejon**, Chair of PEE26, University of Edinburgh			**Larch LT**
9:45-10:15	Keynote Talk 1 **Professor Andrew Garrard** Experiments under the microscope: Why do we teach lab classes and do they have a place in a world with AI? **Chair: John Turner**			**Larch LT**
10:15-10:30	**Sponsors Talk: TecQuipment**			**Larch LT**
10:30-10:45	**Sponsors Talk: Gunt Technology**			
10:45-11:15	**Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**			**Alder LT**
TIME	**EVENT**	**LOC.**	**EVENT**	**LOC.**
11:15-12:30	**Parallel Session 1 - Engineering Practice in HE and Curriculum Transformation** **Chair: Christopher Smith**	**Larch LT**	**Parallel Session 2 - Students Teacher Interactions** **Chair: Debjani Goswami**	**Rowan studio**
11:15-11:30	14. Dreaming A New Undergraduate Engineering Curriculum Together *by Christopher J. M. Smith*		09. Co-Creating Inclusive Engineering Laboratories: Embedding Accessibility and Belonging *by Munira Raja*	
11:30-11:45	7. A Multi-Stakeholder Approach to Practical Curriculum Transformation in Engineering Education *by Zareena Gani*		16. To Get The Cow Off The Ice: On Ultraconcurrent Remote Laboratories and Their Importance For Accessible STEM Laboratory Education *by Marcel Schade*	
11:45-12:00	38. A new 'backbone' for our Mechanical Engineering degree programmes *by Kathrine Dunn*		23. Reinforcing Practical Engineering Education Through an Early-Engagement Research Lab Model *by Sol C. Costa Pereira*	
12:00-12:15	6. Embedding a Professional from Day One (PFD1) Culture into the School of Engineering and Built Environment *by Victoria L. Mellon*		3. Enhancing Students' Engagement by Innovative Experimental Approach for Problem-Solving Questions in the Foundation Year Tutorial *by Debjani Goswami*	
12:15-12:30	1. From Molecules to Meaning: A 10-Dimensional Framework for Post-2030 Chemical Engineering Education *by M.G. Hassan-Sayed*		50. Remote Lab Challenge: Co-Creating the Future of Laboratory Education through Challenge-Based Learning *by Bianca Griech*	
12:30-13:30	**Lunch & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**			**Alder LT**
13:30-13:55	Keynote Talk 2 **Professor Raffaella Ocone** The Role of IChemE and Accreditation Institutions in Practical Engineering Education **Chair: Timm Drysdale**			**Larch LT**
13:55-14:00	Aaron Pennie - Regional Engagement Manager IChemE			**Larch LT**

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<tr><td>TIME</td><td>EVENT</td><td>LOC</td><td>EVENT</td><td>LOCATION</td></tr>
<tr><td>14:05-14:45</td><td>Workshop 1
Chair: Katherine Dunn</td><td rowspan="2">Larch LT</td><td>Workshop 2
Chair: Victoria Mellon</td><td rowspan="2">Rowan studio</td></tr>
<tr><td>14:05-14:45</td><td>27. Induction as the First Engineering Project: Practical Approaches to Building Confidence and Belonging by Matthew Blacklock</td><td>26. Experiments ReLOAD and enLITEened by MartinC. Levelsey</td></tr>
<tr><td>TIME</td><td colspan="3">EVENT</td><td>LOCATION</td></tr>
<tr><td>14:45-15:00</td><td colspan="3">Sponsors Talk: Feedback</td><td rowspan="2">Larch LT</td></tr>
<tr><td>15:00-15:15</td><td colspan="3">Sponsors Talk: Didactic Services DSL</td></tr>
<tr><td>15:15-15:30</td><td colspan="3">Poster Presentations Pitches - 3 mins each - Problem, Solution, Impact
Chair: Chalak Omar</td><td rowspan="9">Larch LT</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">28.Technology Demonstrator: A Modular Open-Lab Concept for Short, Self-Directed, Team-Based Engineering Practice in Higher Education by Matev Zupančič</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">34.Role of Undergraduate Student-Led Societies in Practical Engineering by Amelia Wilkinson</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">41. What Students Really Do In Jupyter Notebooks by Henry Gomez Zeballos</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">45.Project-Based Learning Through Undergraduate Research Internships by Yolanda Sanchez Vicente</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">49. Citizen Science and Energy Literacy as Authentic Assessment in First-year Renewable Energy Engineering Students by Karla G. Cedano Villavicencio</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">47: Development & pre-Evaluation of Batch Reactor Process Laboratory via Remote Access to Develop Accompanying Laboratory Skills using the ADDIE Model by John Turner</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">48. Digital First Labsheets by Andrew Garrard & Edward Browncross</td></tr>
<tr><td>15:15-15:35</td><td colspan="3">10. Teacher-Student Interaction in a Hybrid Remote Laboratory Setting by Yiwen Xu</td></tr>
<tr><td>15:30-16:15</td><td colspan="3">Demonstration Sessions & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters</td><td>Alder LT</td></tr>
<tr><td>15:30-16:15</td><td colspan="3">Demonstration Session 1</td><td rowspan="4">Alder LT</td></tr>
<tr><td>15:30-16:15</td><td colspan="3">21.MIRTE: Choose Your Own (Robot) Adventure by Martin Klomp</td></tr>
<tr><td>15:30-16:15</td><td colspan="3">31.Bringing digitalisation into the laboratory: a Single Tube Condenser case study by Sijie Zhou</td></tr>
<tr><td>15:30-16:15</td><td colspan="3">40. ACE-Lab: A Practical, Application-Led Framework for Control Engineering Education by James E. Pickering</td></tr>
<tr><td>16:15-17:00</td><td colspan="3">Debate/Discussion Pannel
Chair Dave Laureson</td><td rowspan="2">Larch LT</td></tr>
<tr><td>16:15-17:00</td><td colspan="3">35. This house believes the future of practical engineering education is on digital twins coupled to virtual reality? by Dave Laurenson, Andrew Garrard and Tim Drysdale</td></tr>
<tr><td>TIME</td><td colspan="3">EVENT</td><td>LOCATION</td></tr>
<tr><td>19:00-23:00</td><td colspan="3">Gala Dinner in City Centre for ALL</td><td>Ghillie Dhu</td></tr>
</table>

PROGRAMME DAY 2

PEE26 PROGRAM - DAY 2

TIME	EVENT	LOC.
8:30-9:00	**Registration, Breakfast/Coffee, Networking Sessions, Sponsors' Interactions**	**Nucleus GFr**
9:00-9:30	Keynote Talk 3 **Professor Tim Drysdale** Near-Future Practical Work - Digitisation, Industry and Student Experience **Chair: Daniel Orejon**	**Larch LT**
9:30-9:45	**Sponsors Talk: Quanser**	**Larch LT**
9:45-10:00	**Sponsors Talk: Autodesk**	**Larch LT**
10:00-10:15	**Sponsors Talk: Mechatronics**	**Larch LT**
10:15-10:30	**Sponsors Talk: SMC**	**Larch LT**
10:15-10:45	**Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**	**Alder LT**

TIME	EVENT	LOC.	EVENT	LOC.
10:45-12:15	**Parallel Session 3 - Problem Project Scenario Based Learning** **Chair: Patrick J Purcell**	**Larch LT**	**Parallel Session 4 - Transformative Assessment & Digitalisation AI in PEE** **Chair: Mahmoud Masoud**	**Rowan studio**
10:45-11:00	18. Experiential Learning in Thermal Management: A Progressive Practical Teaching Approach to Bridging Theory and Industry Competence in Engineering Education *by Marilize Everts*	**Larch LT**	19. Beam Bending Rig Project: Bringing It All Together *by Steven J Hammer*	**Rowan studio**
11:00-11:15	24. Co-Solving of Non-Hypothetical Problems to Facilitate Innovation *by James R. Croxford*	**Larch LT**	13. Verifying Engineering Competence Through Direct Observation: A Curriculum-Wide Transformation *by Harm van Zalinge*	**Rowan studio**
11:15-11:30	2. Hands-on Teaching and Learning in a Complex Safety Critical Environment *by Zena Green*	**Larch LT**	4. A Formative and Comprehensive Personalised Feedback Technique for Small Cohorts in Electrical Engineering Coursework *by Mahmoud Masoud*	**Rowan studio**
11:30-11:45	8. Small Measures: Practical Tasks for Teaching Statistical Process Control *by John P. Shackleton*	**Larch LT**	15. From Equations to Experiences: A Spreadsheet-based Approach to Teaching Finite Element Theory *by Ben Edmans*	**Rowan studio**
11:45-12:00	20. Designing for Density: Scaling Active, Student-Executed Laboratories in Large-Cohort Engineering Programmes *by Llewellyn Morse*	**Larch LT**	05. From AI Anxiety to Practical Mastery: Scaffolded Approach to AI Modeling in Civil Engineering Education—Building Energy Case Study *by Mohamed I. Abd*	**Rowan studio**
12:00-12:15	11. Industrial contribution to Civil Engineering Programmes at University College Dublin, Ireland *by Patrick J. Purcell*	**Larch LT**	44. LiaScript for real and virtual hardware control *by David Croft*	**Rowan studio**

12:15-13:15	**Lunch & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**			**Alder LT**
TIME	**EVENT**	**LOCATION**	**EVENT**	**LOCATION**
13:15-14:15	**Classroom Demonstration 1** **Chair: Kevin Hanley**	**Larch LT**	**Classroom Demonstration 2** **Chair: Bianca Griech**	**Rowan studio**
13:15-13:45	30. Every Third Week is a Project Week: Embedding Project-Based Learning in Early Engineering Education *by Nathaniel Dacombe*		36. Learn By Doing: An Interactive Lab on Culinary Fluid Mechanics *by Gianluca Lavalle*	
13:45-14:15	33.A Virtual Site Visit to Engage First Year Chemical Engineering Students *by Kevin J. Hanley*		17. Leveraging Peer Feedback for Assessment Literacy: the Peerceptiv Project *by Elena Ioannidou & Joy Lan*	
TIME	**EVENT**	**LOCATION**	**EVENT**	**LOCATION**
14:15-15:45	**Classroom Demonstration 3** **Chair: Martin Levesley**	**Larch LT**	**Workshop 3** **Chair: Rola Saad**	**Rowan studio**
14:15-14:45	43. Refrigeration Remote Lab and Calc App for Thermodynamics *by Rachel Schwind & Sijie Zhou*		29. Co-Designed Engineering Laboratories: A Practical-Based Learning Model Integrating Peer Feedback for Inclusive and Experiential Skill Development (45 minutes) *by Rola Saad*	
14:45-15:15	39. Supporting student-led, self-directed learning with a new structural dynamics remote laboratory *by David Garcia Cava*			
15:15-15:45	32.Rubric grades simplification and marking scheme-feedback unification for best practice in (Chemical) Engineering Laboratories *by Daniel Orejon*		51. Lego® Serious Play®: A multi-purpose tool for co-creation, design and delivery of Practical Engineering Education (45 minutes) *by Simone Dimartino*	
TIME	**EVENT**			**LOCATION**
15:45-15:55	**Sponsors Talk: Engineering 4 Change**			**Larch LT**
16:00-16:45	**Demonstration Sessions & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**			**Alder LT**
16:00-16:45	**Demonstration Session 2**			**Alder LT**
16:00-16:45	37. Bubble/Ballon Bursting for Exemplifying Fluid Dynamics to Pupils *by Duncan Dockar & Rohit Pillai*			
16:00-16:45	22. Design and Implementation of a Low-Cost CAN-Based Adaptive Cruise Control *by Nuttakit Wilairatanaporn*			
16:00-16:45	46. From student project to teaching practice: A green hydrogen generation and utilisation activity for Electrochemical Engineering Education *by Ignacio Tudela*			
16:00-16:45	42. Stirrer Remote Labs in Chemical Engineering Design 1 *by Andrew Brown & Daniel Orejon*			
TIME	**EVENT**			**LOCATION**
16:45-17:00	**Concluding Remarks**			**Larch LT**
17:00	**Lab Visits AND/OR Departure**			**Around KB Campus**

Short Abstracts of the Practical Engineering Education Conference 2026

Curriculum Transformation, Student-Teacher Interactions, Problem- Project- Scenarios-Based Learning, Transformative Assessments and Digitalisation and AI

Organised by the School of Engineering at the University of Edinburgh

The Nucleus Building at the University of Edinburgh, 2 & 3 July 2026, UK

PEE26-001: From Molecules to Meaning: A 10-Dimensional Framework for Post-2030 Chemical Engineering Education

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Conference Theme: United Nations Sustainability Development Goals within the curriculum	Mode of Presentation: Regular Presentation: 1 0 minutes presentation + 5 minutes Q&AX

Abstract

The UN's 2030 Agenda should be treated as a milestone rather than an endpoint. Yet, many chemical engineering curricula remain heavily concentrated in early technical competencies (e.g., balances, transport, reactor/unit operations), while treating ethics, health–safety–environment (HSE), life cycle assessment (LCA), circular economy, and policy interfaces as peripheral "add-ons". This creates a widening mismatch between what we train engineers to do and what societies will require after 2030: not only technically competent graduates, but professionals able to make defensible decisions in complex, uncertain, high-stakes systems spanning energy, water, materials, and health.

In this paper, I present a 10-Dimensional Chemical Engineering (10D) framework as a coherent curriculum map that scaffolds learning from foundational analysis to future-facing, multidimensional decision-making. The model is structured in three layers: (1) Foundational technical dimensions (2D–4D) covering balances, transport, and dynamics/control (including digital twins); (2) Responsible systems integrating ethics, HSE-as-systems-thinking, and sustainability as core engineering obligations; and (3) Societal futures embedding bio-based and circular economy transitions, LCA integration, and societal/policy interfaces alongside a digitally literate, adaptive mindset. I further demonstrate how the framework can be used as a practical program audit and redesign tool, and how it can be mapped to AHEP4 and IChemE expectations to support accreditation-aligned transformation.

By reframing chemical engineering as "from molecules to meaning," the 10D approach offers a structured pathway to graduate engineers capable of delivering post-2030 sustainability, resilience, and justice goals—without sacrificing technical rigor.

Keywords: chemical engineering education; post-2030; sustainability; ethics; HSE; LCA; circular economy; AHEP4; IChemE.

References

PEE26-002: Hands-on Teaching and Learning in a Complex Safety Critical Environment

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Conference Theme: Project & Scenario Based Learning	Mode of Presentation: Regular Presentation: 10 minutes presentation + 5 minutes Q&AX

Abstract

Gaining effective experience can be a challenge for engineering students, due to realistic projects being difficult to reproduce at a smaller scale and access to working on operational civil engineering sites is often difficult to arrange, due to health and safety considerations [1]. Therefore, students studying for their master's level qualification in Railway Systems Engineering were invited to attend a residential course at a heritage railway in Derbyshire to gain hands-on experience of track renewals and mechanical signalling. This has included rebuilding of switch and crossing work, rail and sleeper replacement, alongside other substantial track engineering tasks. The heritage railway is used to working with and training volunteers, so they have the skills set to allow students to develop engineering skills in a safe, but very real environment.

Research has shown that students gain a valuable understanding of track structure and systems as well as empathy and appreciation for track workers when undertaking such practical work. Students also become aware of the great risks involved in working on operational railways and learn skills to address these. Feedback from students has been exceedingly positive in terms of confidence building and in gaining practical skills, while the heritage railway team values the work students have undertaken and enjoys the interactions.

There are a growing number of community projects across the UK that could use volunteers to assist with renovations [2]. By adopting an approach similar to that adopted at the heritage railway, there is an opportunity for Engineering departments to give students real world experience, while visibly supporting the sustainability of their local communities.

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PEE26-003: Enhancing Students' Engagement by Innovative Experimental Approach for Problem-Solving Questions in the Foundation Year Tutorial

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Conference Theme: Engineering practice in Higher Education and Curriculum Transformation Programme	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

This study reports on an innovative tutorial redesign in a physics-based Foundation Year module to enhance student engagement and conceptual understanding of STEM through experimentally focused tutorials. Student engagement is a multidimensional construct encompassing behavioural, emotional, and cognitive dimensions and is strongly linked to learning outcomes and retention in higher education.[1] Persistent challenges, including low participation, inconsistent attendance, and student requests for more interactive learning, prompted a re-evaluation of the traditional tutorial approach.

Previously, tutorials centred on individual numerical problem-solving, which supported procedural practice but offered limited opportunities for conceptual discussion, experimental reasoning, and peer interaction.[2] Such approaches are restrictive in STEM education, where students benefit from engaging with physical phenomena and applying theoretical principles in meaningful, real-world contexts.[1,3] To address these limitations, the tutorial format was redesigned to emphasise experimental, real-life physics scenarios delivered through structured group work.

In the redesigned tutorials, students collaborated in small groups to analyse application-based problems inspired by experimental contexts, interpret physical behaviour, and connect theoretical models to observable outcomes. These experimental tutorial classes prioritised discussion, prediction, interpretation, and collective problem-solving, supporting deeper conceptual understanding alongside mathematical reasoning. This approach aligns with evidence that active, experimental, and collaborative learning environments improve student understanding and performance in STEM disciplines.[3–5] Group-work-based tutorials have also been shown to enhance engagement, peer learning, and retention, particularly within large or diverse cohorts.[2,6]

The effectiveness of the intervention was evaluated using end-of-module student surveys alongside attendance monitoring. While a small minority preferred independent work, most students reported increased engagement, improved conceptual understanding, and a stronger ability to relate theory to real-world and experimental contexts. These outcomes align with established student engagement models and interactive learning research.[1,6,7]

Overall, experimental, group-based tutorials significantly enhance student engagement and conceptual understanding in STEM education, providing an effective pedagogical framework for STEM education.

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PEE004: A Formative and Comprehensive Personalised Feedback Technique for Small Cohorts in Electrical Engineering Coursework

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Conference Theme: Transformative assessment & practical work feedback	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

The effectiveness of module delivery is measured by student achievement of module learning objectives. One of the measurement tools for assessing how students achieve learning outcomes is assessment. In any assessment, formative or summative, students make mistakes, and the tool for correcting this is detailed feedback that ensures students' learning. Rarely in higher education institutes do students receive feedback after the module's final exam. So, to enhance the student's skills and ensure the achievement of learning outcomes, assignments and feedback through coursework are considered a powerful tool for enhancing students' skills. If feedback is superficial, learning outcomes are not achieved. This paper introduces a feedback technique for small cohorts (30 to 50 students) to support students in overcoming their learning weaknesses. As a case study: Two electrical engineering modules are selected, Level 2 and Level 3. The quality of this feedback technique is assessed through statistical measurement of bias and enthusiastic student response. The drawback of this technique is that more time for marking and editing is required, which is why it is selected for small cohorts or small groups.

Intended Outcomes: To present an effective and consistent marking and feedback method that demonstrates a positive impact on student academic development and compare with previous methods.

Application Design: A marking spreadsheet that breaks down feedback into easily digestible chunks for students to understand exactly how to improve. This also presents a better method for future implementation with automatic marking if needed for large cohorts.

Findings: The proposed method is found to be well-received by students, with none raising concerns over their mark received. Statistical measurements, when compared with the traditional method, show that it is more consistent and objective. Furthermore, measuring student performance after incorporating this feedback shows substantial improvement. This study shows the advantage of this more systematic approach to marking feedback, and could be used in conjunction with machine learning to provide high-quality feedback for students in large cohorts.

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PEE005: From AI Anxiety to Practical Mastery: Scaffolded Approach to AI Modeling in Civil Engineering Education—Building Energy Case Study

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Conference Theme: Digitalisation and Artificial Intelligence Practical Engineering Higher Education	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

The integration of artificial intelligence (AI) into engineering education demands pedagogical strategies that cultivate both technical proficiency and positive attitudes toward AI-driven modeling. Undergraduate engineering students often face programming anxiety, cognitive overload, and reluctance to interact with algorithmic systems. Existing research highlights that scaffolded learning environments can convert such anxiety into self-efficacy by progressively enhancing competence and autonomy. This study presents a behaviorally progressive Build-and-Test framework implemented in an undergraduate civil engineering course involving 60 students from two universities in Hargeisa, Somaliland. Participants addressed authentic building energy prediction challenges using supervised regression models. The intervention emphasized behavioral engagement across four stages: (1) low-stakes exploratory data analysis to alleviate anxiety and cognitive overload; (2) guided regression modeling for initial mastery; (3) structured feature comparison to foster analytical decision-making; and (4) autonomous model refinement guided by engineering metrics (R^2 and RMSE) to promote ownership and agency. Employing a quasi-experimental pre/post design, the study measured programming anxiety, perceived cognitive load, AI self-efficacy, and conceptual understanding. Findings revealed statistically significant reductions in coding anxiety and extraneous cognitive load ($p<.05$), alongside enhanced regression modeling performance and superior project submissions. Participants demonstrated greater willingness to experiment with AI models, heightened confidence in interpreting validation metrics, and improved independent problem-solving. Reflective accounts reflected a transition from apprehension to proactive engagement with sustainability-focused energy modeling. These results underscore the efficacy of scaffolded, problem-based AI integration in driving measurable behavioral shifts, reframing AI as an accessible engineering tool for real-world problem-solving rather than a source of intimidation.

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PEE006: Embedding a Professional from Day One (PFD1) Culture into the School of Engineering and Built Environment

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Conference Theme: Engineering practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

The School of Engineering and Built Environment (EBE) has adopted a holistic PFD1 ethos as a unifying framework for curriculum transformation, enhancement of the student experience, and improved graduate readiness. Operating as a "golden thread" across all courses, PFD1 now shapes strategic and pedagogical decision-making at every level. Research shows that curriculum redesign which strengthens professional skills in Engineering can enhance the student experience and better bridge the gap between education and practice (O'Rieley et al., 2025; Murray et al., 2022). The School's 2024 curriculum revalidation therefore provided an opportunity to streamline assessment, reduce complexity, and expand authentic, real-world learning experiences.

However, curriculum change alone is insufficient to fully support students. Studies highlight that engineering clubs, competitions, and maker spaces contribute to belonging, confidence, and the application of theory through extended engineering practice (Jamison et al., 2023; Olewnik et al., 2023; Hinkle et al., 2019). In response, the School has developed a coherent suite of co- and extracurricular initiatives aligned with professional practice and identity formation.

Key developments include early-engagement activities such as Kickstart (induction for PEIs and student societies); structured, practice-based opportunities like Maker Monday; academic support interventions through the Engineering Café and PASS mentoring; and co-created pedagogic enhancement projects such as Five Features of Feedback. Collectively, these initiatives promote a culture where learning is situated in real-world problems, multidisciplinary project work, and continuous professional development rather than isolated subject specific tasks.

Bennesden et al. (2020) argue that establishing a shared vision such as PFD1 requires collaborative staff development to sustain cultural change. To support this shift, the School has introduced regular development days to strengthen collaboration in module and course teams, encourage practice sharing, and grow engagement with the scholarship of teaching and learning (SoTL). Early indicators point to improved student engagement, clearer alignment with professional competencies, and emerging gains in graduate readiness. This paper reflects the practical considerations, successes, challenges, and ongoing work required to sustain the continuous enhancement of the PFD1 ethos.

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PEE007: A Multi-Stakeholder Approach to Practical Curriculum Transformation in Engineering Education

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Conference Theme: Engineering Practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Engineering employers increasingly seek graduates who can demonstrate practical competence, systems thinking, and the ability to work collaboratively in authentic contexts [1]. Meeting this expectation requires practical teaching that goes beyond procedural laboratory exercises to develop the kind of transferable, hands-on skills that define engineering practice. This paper argues that sustained, systematic co-creation between students, academics, and Post Graduate Teaching Assistants (PGTAs) can measurably improve both student satisfaction and learning outcomes [2] and that this approach offers a replicable model for research-intensive departments seeking to modernise practical education. Since 2022, a dedicated departmental Practical Teaching Committee has led a curriculum-wide transformation centred on three interconnected initiatives. First, learning outcomes were systematically mapped to assessment strategies, informing the replacement of outdated experiments and laboratory rigs with modern, pedagogically relevant systems supported by significant departmental investment. Second, PGTAs were equipped through lab-specific training materials and actively involved in commissioning and deploying new equipment, repositioning them as co-educators rather than passive demonstrators [3]. Third, a student-led, in-house design-and-build programme was established, in which students construct experimental rigs that demonstrate core theoretical concepts taught in engineering modules. Building on this, multi-module experimental rigs are currently being developed in partnership with a student collaborator, designed to embed systems thinking and replicate authentic, real-world engineering contexts. Internal survey data (650 students across 15 modules, each year) show marked improvements following these reforms: student satisfaction rose from 2 to 4, and perceived learning experience from 1 to 4, on a 5-point scale. Sustainability has been embedded structurally rather than symbolically: the undergraduate teaching laboratories have received UCL's Bronze LEAF accreditation, and students are now explicitly assessed on their engagement with the UN SDGs in individual projects [4]. This paper discusses how co-creation at scale becomes feasible, the pedagogical principles underpinning each initiative, and the implications for departments undertaking similar transformations.

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PEE008: Small Measures: Practical Tasks for Teaching Statistical Process Control

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Conference Theme: Problem, Project & Scenario-Based Learning	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

'Tolerance' (i.e., the geometric variation that a designed component will tolerate and still function satisfactorily) and machine 'capability', (i.e., the inherent geometric variation resulting from a specific process on a specific component), are terms which are regularly conflated by students, but which, whilst related, represent significantly different concepts. This paper reports on a series of practical exercises developed for the teaching of Statistical Process Control (SPC), a manufacturing technique dependent on these two constructs.

Using a basic set of equipment, the first exercise employs students in a simple manual manufacturing process from which sample 'components' are taken and measured accurately in order to produce a 'capability study'. The capability study uses a graphical approach based on a normal probability plot to illustrate issues of centering, kurtosis, and the prediction of defect rates.

Subsequently, the introduction of desk-top CNC machining facilitated the further development of student projects based around production quality and the exploration of Taguchi off-line quality techniques.

Feedback from students is that the simple practical exercises clarify and reinforce the theoretical concepts taught in the traditional lectures which also form part of the course on advanced manufacturing. Using such hands-on approaches has demonstrated the improved learning outcomes to be gained from students physically engaging with what are, at their core, physical concepts. Moreover, it would be easy to underestimate the incidental tacit learning and skills development around metrology that also happen when students are engaged in this way.

References

PEE009: Co-Creating Inclusive Engineering Laboratories: Embedding Accessibility and Belonging

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Conference Theme: Student-teacher practical engineering interactions	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Practical engineering laboratories are central to student learning in Engineering, yet they can unintentionally reproduce barriers to participation, accessibility, and belonging[1,2]. This project addresses these challenges through a co-creation approach, engaging students[3] and staff, in collaboratively redesigning lab environments and activities to be more inclusive, equitable, and aligned with CDIO[4], IET accreditation[5], and EDI sector priorities[6,7].

Structured audits of lab spaces and activities, combined with student and staff feedback, identify structural and curricular barriers affecting engagement, participation, and learning outcomes. Insights from this process inform the development of a transferable EDI-in-Labs Toolkit, which provides practical guidance, checklists, and strategies for inclusive laboratory design and delivery, supporting professional and accreditation standards.

In parallel, the project co-designs and pilots new group-based EDI lab-based exercises and assessments for undergraduate cohorts, embedding inclusive pedagogy to promote equitable participation, shared responsibility, and a sense of belonging. These activities provide applied learning in an inclusive context and provide a framework for scalable implementation.

The presentation will showcase the toolkit and the lab activities, illustrating how co-creation and evidence-informed innovation can transform engineering curriculum, advance EDI objectives, and align with professional priorities, offering a model for inclusive practical education across STEM disciplines.

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PEE10: Teacher–Student Interaction in Blended Engineering Laboratories

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Conference Theme: Student-teacher practical engineering interactions	Mode of Presentation: Poster

Abstract

Engineering laboratory teaching usually emphasises disciplinary content; however, student learning is also shaped by teacher-student interactions, including guidance[1], active student participation[2], and a sense of belonging[3]. In undergraduate engineering courses, laboratory settings mediate teacher-student interaction through technology, reshaping the conditions under which interaction occurs. Although educational frameworks have been used to analyse online and blended learning, their application to engineering laboratories remains limited, especially in blended settings where interfaces, networked equipment, system feedback, and communication channels mediate how students identify problems, explain difficulties, and receive teacher support. How can teacher-student interaction be conceptualised when it is physically co-located, technologically mediated, and later continued independently?

The poster adapts the Community of Inquiry (CoI) framework to examine a proposed blended laboratory setting consisting of a co-located workshop phase followed by an independent home phase. The CoI framework provides a starting point by highlighting social presence, cognitive presence, and teaching presence in online learning experiences[4]. Therefore, teacher-student interaction is conceptualised as a cross-phase process that is initiated face-to-face, mediated through technological systems, and sustained during independent home-based work.

In the co-located workshop, early face-to-face support can build social connection and help-seeking confidence, while modelling and troubleshooting make cognitive routines visible; meanwhile, teaching support helps through emotional support and reducing technological interference. As students move to independent learning, interaction becomes less immediate but can be carried forward by enabling students to reuse guidance and routines established in the workshop.

The poster contributes a CoI-informed cross-phase model that supports the design of blended laboratories by mapping social, cognitive, and teaching presence onto teaching actions and providing practical suggestions.

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PEE011: Industrial contribution to Civil Engineering Programmes at University College Dublin, Ireland

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Conference Theme: Problem-, Project-&Scenario-based learning	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Active learning is anything course-related that all students are called upon to do other than simply watching, listening and taking notes [1]. Hands-on activities in workshops, laboratories and in the field are perfect examples of active learning and make students aware of the practical dimension of their work. [2].

In the School of Civil Engineering, University College Dublin (UCD), a number of pedagogical approaches have been adopted to facilitate the development of the awareness of practical engineering skills and engineering practice within the curriculum. These include case studies, industrial placements, projects, industry speakers, laboratories, workshops and visits to industrial or commercial installations. The goals of this practical education include: Hands-on experience, Learning through failure, Appreciation of Civil Engineering materials, Introduction to sustainability, Fostering creativity, Working in multi-disciplinary settings, Designing innovative solutions, Working individually and in group settings, Appreciation of ethical responsibilities.

To inculcate this awareness of practice within the curriculum, the School employs a significant cohort of practitioners who make an invaluable contribution to achieving the practical competences of graduates required to meet the requirements of professional accreditation. This short presentation will describe how the contribution of practitioners is integrated across the various stages of the programmes in a cohesive manner to better prepare students for the workplace. The challenges of embedding practical engineering within the programmes, for example, health and safety, timetabling, assessment etc, that need to be addressed to produce programmes that integrate theory with practice to achieve the desired learning outcomes will be discussed.

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PEE012: Transforming Assessment and Feedback in Engineering Education: A Human–AI Collaborative Model - WITHDRAWN

Conference Theme: Transformative assessment & feedback	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

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PEE013: Verifying Engineering Competence Through Direct Observation: A Curriculum-Wide Transformation

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Conference Theme: Transformative assessment & practical work feedback	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

This paper presents an ongoing, large-scale transformation of the Electrical Engineering and Electronics laboratory curriculum, driven primarily by the need to redesign how practical engineering competence is assessed. The initiative responds to identified skills gaps, assessment vulnerability to generative AI, and student disengagement arising from prescriptive, script-led laboratory exercises and traditional post-lab reporting, where proficiency is described rather than demonstrated.

Practical provision across all years is being restructured to create 300 guided learning hours per year explicitly dedicated to the development and verification of engineering skills and professional competencies. Achieving this within significant curricular constraints required careful strategic planning and a protected "sandbox" development phase to design, test, and stress-test new assessment models prior to implementation.

Conventional weekly experiments are being replaced with sustained mini-projects, but the core innovation lies in assessment. Written lab reports are being phased out in favour of in-lab competency verification through Direct Observation of Practical Skills (DOPS), supported by curated evidence portfolios. Students explicitly identify, demonstrate, and collect evidence of defined competencies, shifting from passive compliance with briefing requirements to active ownership of professional skill development. Competence is assessed through performance, iteration, and reflection rather than retrospective technical narration.

By reframing laboratory work as a structured but low-risk space to experiment and learn through failure, the model reduces high-stakes pressure while strengthening authenticity. This performance-based approach fosters resilience, creativity, and professional agency, and better equips graduates to articulate and deploy their skills in the workplace. The paper discusses the strategic rationale, implementation challenges, and early reflections from this assessment-led curriculum transformation.

References

PEE014: Dreaming A New Undergraduate Engineering Curriculum Together

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Conference Theme: Curriculum co-creation including students' voices	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Student Partnership is at the heart of the new Scottish Quality Assurance and Enhancement arrangements – Tertiary Quality Enhancement Framework (TQEF) [1] - and reflects a wider movement of active student partnership in UK Tertiary Education decision-making. However, student participation in is not always inclusive [2], even though literature highlights the benefits of co-creation and students-as-partners [2,3]. Consequently, there is a practice gap as to how co-creation between staff and students can be effectively implemented within a curriculum review process.

This staff-student collaborative paper details how a participatory change approach (Appreciative Inquiry [4]) across students, industry, alumni and staff is being used to guide a departmental review of undergraduate engineering programmes; Appreciative Inquiry has 4 steps – Discover, Dream, Design and Deliver. This paper outlines the specific collaboration process between academics and current students to-date: co-design of student-wide survey with Departmental Representative that looks for positive student experiences [Discover] and invites them to Dream about ways to enhance the programme; and the co-analysis of these results with Student Representatives to ensure that student language is central to how these results inform future steps. The paper will also highlight how this approach complements the existing centrally collected data to enhance curriculum design (including learning, teaching and assessment approaches).

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PEE015: From Equations to Experiences: A Spreadsheet-based Approach to Teaching Finite Element Theory

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Practical use of finite element analysis (FEA) software is a key topic taught in mid- to late stages of Mechanical, Aeronautical and Automotive Engineering degree courses. An appropriate understanding of underlying theory supports engineers in setting up models and interpreting results from analyses; and enables students to demonstrate AHEP4 learning outcome C3/M3. However, a rigorous, mathematical treatment of the topic is time-consuming to teach, often challenging for students and not essential for practicing engineers.

This presentation describes the move from a teaching framework based on lectures and written tutorials and a written exam to an approach centred on the use of spreadsheets in both teaching and assessment. In the assessment task, students were required to complete a individualized, scaffolded coursework task designed to be AI-proof. Students were encouraged to use online validation tools to visualize and check their results. This change was implemented in three modules, consisting of part-time and full-time students at levels 6 and 7 at Sheffield Hallam University in 2024-25.

The presentation gives an overview of the module redesign process, including definition of learning objectives as desired student capabilities (following Bowman [1]) and implementation of a focused and consistent structuring of lectures and IT sessions. Measured outcomes from the intervention are presented, including details assessment performance, results from a structured questionnaire and unprompted feedback in module evaluations. Outcomes were strongly and consistently positive, and improvements in attendance and engagement were also noted. Analysis of results gives insight into the mechanisms by which the method gives rises to improvements. Limitations and recommendations are discussed.

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PEE016: To Get The Cow Off The Ice: On Ultraconcurrent Remote Laboratories and Their Importance For Accessible STEM Laboratory Education

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Conference Theme: Student-teacher practical engineering interactions	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Digitalisation, flexibilisation and diversity gain increasing attention in higher education. This also applies to STEM education and laboratory experiments. Digital laboratories enable students to perform experiments independent of time and location [1]. Moreover, they enable students to access laboratory spaces when on-site laboratories remain close to them, e.g., due to disabilities or chronic illnesses which is important as study-impairing disabilities are rather prevalent (16 % in Germany in 2021) [2].

However, moving into digital spaces comes with new barriers as digital accessibility needs to be considered by law [3, 4]. Considerations include colours, contrast, text-sizing, zoom and line breaks, flashes, text-alternatives for images, links, handles and buttons, timers and time-outs, keyboard control, headings, focus, and compatibility, e.g., PC and mobile or different operating systems, and assistive technologies (c.f. [5]).

However, the elephant in the room certainly revolves around closed captions, audio-descriptions, and alt-text for changing images. This proves difficult with live laboratories, like remote laboratories, desktop- or immersive VR, as many variables are subject to change and the digital environments are to be described live. This can be possible with the use of trained AI. That, however, increases cost and required resources immensely.

The most promising option to resolve this issue is the use of ultraconcurrent remote laboratories (UCRLs) – pseudo remote laboratories that display pre-recorded data. Their advantages include scalability, easy transferability and long-term anchoring as well as lower cost and maintenance [6].

Employing UCRLs however, requires that the combination of variables is low enough to record every outcome ahead of time. Thus, intricate laboratories are more difficult to realise. Solutions to this include compartmentalisation into smaller sub-laboratories as well as reducing the number of sensible variable-combinations by pedagogical framing and the embedded teaching-learning-scenarios.

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PEE017: Leveraging Peer Feedback for Assessment Literacy: the Peerceptiv Project

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Conference Theme: Transformative assessment & practical work feedback, Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Classroom Demonstration

Abstract

The University of Edinburgh attracts incredibly diverse and motivated student talent. Due to the diversity of the student population and the particularities of the UK HE marking scheme, students find their expectations are not met when they engage with assessment and feedback and face disappointment. They also often find themselves being passive recipients of feedback, rather than active agents taking ownership of their learning.

Taking into account the NSS question of "feedback helps me improve my work" being the lowest score in the NSS, the School of Engineering sought to understand how to best raise student assessment and feedback literacy, as well as understand what feedback students find helpful.

However, the challenges of increasing class sizes and financial constraints, particularly in the area of staff recruitment, make it very difficult for staff to provide adequate volume of feedback to all students, particularly formative feedback. As such, the School launched an initiative to embed more peer feedback activities in large courses, in order to give students more opportunities to internalize the marking criteria, while providing each other with personalized feedback. While the value of peer feedback is well documented in educational literature[1,2], it was found that it was underutilized in the School of Engineering, with very few courses opting for peer feedback outside of group evaluations.

In this session, we will explore how the School rekindled staff interest in peer feedback, what tools in the area of learning technology made this possible and how the outputs of a peer feedback activity can be leveraged beyond the activity itself.

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PEE018: Experiential Learning in Thermal Management: A Progressive Practical Teaching Approach to Bridging Theory and Industry Competence in Engineering Education

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Engineering employers increasingly seek graduates who can demonstrate practical competence, systems thinking, and the ability to work collaboratively in authentic contexts[1]. Meeting this expectation requires practical teaching that moves beyond procedural laboratory exercises and engages students in structured experiential learning cycles that connect theoretical knowledge to real-world applications[2]. This paper argues that a two-year scaffolded, experiential teaching intervention in heat transfer can measurably improve knowledge retention, student satisfaction, and perceived learning experience — offering a replicable model for engineering programmes seeking to strengthen skills development and graduate employability through progressive practical curricula. The intervention is structured around an experiential learning cycle that progressively builds students' practical competence over two years of the undergraduate programme. In the first year, students gain hands-on experience with concentric tube-in-tube and plate heat exchangers, exploring the effects of temperature difference, flow rate, and flow configuration on overall heat transfer performance. Building on this foundation, second-year students investigate forced and free convection across flat, pinned, and finned surfaces, broadening their awareness of heat exchanger types, as well as understanding of design trade-offs for different engineering contexts. The intervention culminates in an authentic design-and-build assessment, in which students design, manufacture, and test their own heat sink — developing the applied decision-making skills demanded by industry[3], and applying their heat transfer knowledge to thermal management. Student feedback indicates improvements in knowledge retention and learning experience, consistent with evidence that experiential, programme-level practical teaching produces stronger graduate competencies than isolated laboratory exercises[2]. This paper discusses the pedagogical rationale, design principles, and lessons learned, offering a transferable model for embedding experiential learning in thermal sciences and related engineering disciplines.

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PEE019: Beam Bending Rig Project: Bringing It All Together

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Conference Theme: Transformative assessment & practical work feedback	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Authentic assessment can be challenging when engineering students experience multi-disciplinary learning [1]. We have developed a cantilever beam bending [2] rig project that assesses skills developed in different subject areas from our first year UG mechanical engineering programme.

The rig specification allows the development and assessment of the range of subjects taught in the programme. **Hand tool skills** are used to create a frame made from machine building system components. **Mechanical design and CAD skills** are used to design the rig layout and choose appropriate components and materials for the main systems. **Electronics and programming knowledge** is used to capture data and control the bending of the beam. Each rig uses a servomotor with an aluminium yoke to deflect the beam and a load cell amplifier controlled by an Arduino to measure the reaction force at the root of the beam. **Data analysis and mathematics skills** are used when analysing, recording and presenting data from the load cell. **Group working skills** are developed through interacting with peers in small groups and planning and managing the development of the rig. **Communication skills** are tested in an individual technical report, which allows students to draw on their knowledge of these different subject areas and present their results: what is the Young's Modulus of the beam material [3]?

This approach allows students to develop a more holistic view of their engineering education through experiencing authentic assessment. Some challenges, including difficulties in encouraging group engagement, understanding how to calibrate load cells, and the importance of accurate measurement of deflection and beam dimensions, will be presented.

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PEE020: Designing for Density: Scaling Active, Student-Executed Laboratories in Large-Cohort Engineering Programmes

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Large-cohort engineering laboratories often struggle to sustain meaningful hands-on engagement when structural constraints limit direct student interaction with equipment. In a first-year Mechanical Engineering module with approximately 300 students, earlier student feedback described the laboratories as overly procedural, focused on recording data rather than performing experiments, and lacking practical ownership. Under these conditions, Postgraduate Teaching Assistants (PGTAs) frequently executed experiments while students observed, reducing embodied engagement. Active participation and experiential learning are strongly associated with improved conceptual understanding and professional competence in engineering education [1,2].

This study reconceptualises equipment density as a participation-limiting variable in large practical modules. With up to 20 students per apparatus, limited access constrained direct execution and restricted development of experimental setup skills, data acquisition, collaborative problem-solving, and interpretation of system-level behaviour. Through targeted infrastructure investment, rig capacity was expanded across three core laboratories - Jet Impact (momentum conservation), Heat Exchanger (heat transfer and flow configuration), and Refrigeration (thermodynamic cycles) - reducing density in one case from approximately 20 students per rig to around 6. This structural change enabled a parallel pedagogical redesign: students executed experiments directly using structured instructions, while PGTAs were repositioned as facilitators, without increasing staffing levels.

Students assembled apparatus, configured flow conditions, collected and analysed data, plotted system relationships, and evaluated discrepancies between theory and measurement. Following the redesign, structured survey feedback from 391 first-year students showed strong outcomes: PGTA engagement averaged 4.7/5 and 97 percent rated the laboratories as Good or Excellent in supporting theoretical understanding. Qualitative responses repeatedly emphasised hands-on execution, equipment manipulation, teamwork, and the ability to “do it ourselves” as central to linking theory and practice. The case further examines supervision ratios and sustainability trade-offs when scaling active laboratory learning, aligning with broader evidence on active learning in STEM education [3].

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PEE021: MIRTE: Choose Your Own (Robot) Adventure

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Conference Theme: In-house design and build of practical education equipment in line with fundamental and applied research in the taught curriculum integration	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

The use of robots in Higher Education is often challenging due to cost, obsolescence and maintenance, especially when dealing with large student numbers (100-500+). This is why at Delft University of Technology (TU Delft) a family of affordable open-science modular educational robots has been created for use in upper secondary and university settings: the MIRTE Robots [1]. MIRTE, which stands for MIRTE: an Inspiring Robot for Technology Education is a truly multi-purpose open science robot with all its material available as open source, open hardware, and open educational resources (https://mirte.org). By being open source, MIRTE is becoming much more than just another in-house developed educational robot, rather it is a community where likeminded educators and developers meet and engage through channels such as GitHub and Discord and where educators are not restricted to a specific goal of purpose dictated by the robot. Instead, they are free to adapt and expand MIRTE to suit their own needs and share resources to grow and further the MIRTE community. To illustrate this during this practical demonstration, representatives from two universities, TU Delft and Dublin City University (DCU) will show (using the actual robots and with audience participation if time allows) how they use MIRTE in their education, and in particular also focus on how the ease of use of open science robots showcasing how DCU implemented MIRTE as an undergraduate final year project platform when they adopted a MIRTE after a workshop at SEFI 2025[2,3]. In addition to providing an engineering solution, MIRTE develops digital literacy and design skills valuable to a range of graduates.

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PEE022: Design and Implementation of a Low-Cost CAN-Based Adaptive Cruise Control

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

This final-year BSc project designs a scaled down system that reproduces the core function of adaptive cruise control (ACC) [1] in a vehicle using controller area network (CAN) [2]. The aim is to observe how sensing, communication, and actuation interact in a real time automated control application [3]. Three electronic control units (ECUs) connected to a two-wire CAN bus, a control interface for activation and setpoints, a sensing node that estimates lead vehicle distance using ultrasonic ranging and transmits periodic CAN updates, and an actuator controller that uses these inputs to adjust DC motor speed. This motor is used to emulate vehicle combustion/electric motor. The system is created without dependence on proprietary automotive equipment. Component selection priorities availability, cost, and robustness, while retaining the architecture and key characteristics of CAN.

Using CAN version 2.0b to observe network operations such as message prioritization, bit synchronization, fault confinement and automatic retransmission [4]. Robustness measures [5, 6] such as message timeouts, plausibility checks on sensor values. Control behaviour is implemented using a finite state structure that manages operating modes such as inactive, active, and regulating [7]. An optional proportional integral derivative extension is included to allow exploration of response smoothness, stability, and the trade-off between control performance and communication constraints. Performance is observed using indicators including message delivery reliability, timing behaviour under increased bus activity, and the ability of the closed loop system to regulate speed to maintain the selected following distance across operating conditions.

The low-cost design and implementation allow automating and testing vehicular applications with enhanced feasibility [8]. Providing practical experience in designing, validating wiring and inspection of CAN traffic identifier, DLC, data payload, CRC/ACK behaviour. Developing practice-oriented competencies such as measurement, experimentation, troubleshooting, and system integration that complement lecture-based theory and align with professional engineering practice. [9].

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PEE023: Reinforcing Practical Engineering Education Through an Early-Engagement Research Lab Model

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Conference Theme: Students as Practical Engineering Educators	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

This work presents a new educational initiative, currently in its first academic year, that complements programme laboratory teaching in Mechanical Engineering and Energy & Environmental Engineering through an open-access Research Lab. As the lab is still being established, students actively contribute to its development by designing experimental setups, receiving training in experimental techniques, numerical modelling, and laboratory practice, and participating in research project workshops. Through these activities, students build broader skills in scientific communication, presentation, teamwork, and research writing, supporting their academic and professional growth. This approach is supported by evidence showing that structured, hands-on experiences, such as undergraduate research and internships, significantly enhance the technical competence, confidence, and academic development of engineering students [1–3]. A central component of the initiative is the Volunteer-to-Intern pathway, which enables students, from early years, to join ongoing research alongside early-career researchers. Students may enter the Research Lab at any stage of their degree and progressively build skills, with the potential to continue developing them through the final-year project. They typically begin as volunteers, gaining experience and confidence, as engagement deepens, some could advance to paid internship roles supported by internal or external funding. Early instances of volunteer withdrawal highlighted the need for structured onboarding and sustained mentoring, consistent with findings in the literature on effective undergraduate research environments [1,3]. This initiative will reinforce and supplement practical learning in programme laboratories, particularly as scheduled lab provision becomes more constrained, by offering additional opportunities to apply and extend structured skills to open-ended research problems. This strengthens conceptual understanding, enhances practical capability, and supports the development of engineering judgement and professional identity, outcomes strongly associated with undergraduate research experiences [2].

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PEE024: Co-Solving of Non-Hypothetical Problems to Facilitate Innovation

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Co-solving of non-hypothetical problems responds to growing concern that 'authentic assessment' has become a loosely applied buzzword, with contested definitions and variable measurement[1,2,3,4].

Too often, students are presented with carefully constructed 'real-world' tasks for which the solution is already known to the academic or industrial communities. Such approaches may simulate professional practice but rarely reproduce the epistemic uncertainty of professional engineering.

We present a practical framework that moves beyond employer-endorsed tasks that merely resemble professional work, to co-solving genuine problems with unknown solutions in partnership with academic staff and external stakeholders. These problems are unsolved, messy and frequently 'wicked', demanding negotiation of ambiguity, competing constraints and incomplete data[5,6]. Students are positioned as partners in enquiry and delivery[7], while the academic role shifts from instructor to facilitator.

Learning is supported through structured, dialogic feedback cycles involving both staff and industry collaborators, ensuring progress despite uncertainty and the possibility of partial or provisional solutions[8,9]. Within a supportive and nurturing environment, the absence of a predetermined answer enables genuinely inclusive participation; students can approach complex challenges through diverse strategies while maintaining rigour and professional relevance[10].

The paper outlines design principles, a process model, and exemplars from engineering modules where student teams used authentic tools, data, and environments to deliver outcomes that were genuinely new to the partner organisation. We argue this approach better nurtures confidence, belonging and creativity, converting student enthusiasm into innovation with a tangible and lasting legacy.

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PEE025: Practical Vehicle Automation using CAN - WITHDRAWN

Conference Theme: Students as Practical Engineering Educators	Mode of Presentation: Classroom Demonstration

References

PEE026: Experiments ReLOADed and enLITEened

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Conference Theme: Engineering practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Workshop

Abstract

Created in 2000, at the University of Leeds, ReLOAD (Real Labs Operated At Distance) has now been successfully delivering experiments to students locally, nationally and internationally for ¼ century [1]. The "Distance" in ReLOAD, has been anything from millimeters to thousands of kilometers, with students having access to video, graphical and raw data, delivered to their phone, tablet, laptop or PC via a standard web interface.

The system has been developed significantly over this period. In the last academic year alone, it delivered over 46,000 sets of experimental data to over 1000 student users, mainly in the UK and China. Increasing numbers of engineering students, at both postgraduate, undergraduate and foundation level, has resulted in over 40,000 experiments already delivered this academic year alone (up to the end of February 2026). Predictions, based on our historical, rich database, show this number will increase significantly in future years.

The Leeds Institute for Teaching Excellence (LITE) is currently supporting us to consider how we might share this system to support year 12 and 13 students who may be interested in the practical aspects of the physical sciences but lack resources for experimental enquiry.

We would like to run a workshop (or deliver a presentation) to show the benefits of using a system like ReLOAD to deliver;

i. co-created, accessible experiments using, in-house designed, and built practical education equipment, shared between international universities,

ii. immediate, automated, graphical feedback within practical sessions and authentic, challenge-based assessment, as an alternative to a traditional lab report,

iii. efficient use of shared resources to enable expansion of student numbers in a challenging financial climate.

A workshop would allow us to run demonstrations and develop further partnerships with other interested in supporting and inspiring year 12 and 13 students who may be considering engineering as a future career.

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PEE027: Induction as the First Engineering Project: Practical Approaches to Building Confidence and Belonging

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Conference Theme: Student-teacher practical engineering interactions	Mode of Presentation: Workshop

Abstract

Induction is often treated as an administrative introduction to university life. This workshop reframes induction as the first engineering project of the programme: a deliberately structured, activity-based experience designed to build confidence, belonging and practical readiness before formal teaching begins.

We will share and run elements of our two-day Level 4 induction for Mechanical and Automotive Engineering students. Day one introduces programme expectations and professional identity before students undertake a team-based campus challenge. Working in small groups, they solve clues located in laboratories, IT rooms (including logging into university systems), teaching spaces and common areas. The activity familiarises students with the physical and digital infrastructure of their degree while modelling collaboration, navigation and problem solving.

Day two focuses on cohort-building through structured icebreaker and problem-solving activities, including negotiation tasks, estimation challenges and team design exercises. These low-stakes activities establish early norms of teamwork, communication and participation, reflecting the activity-based and lectorial approach that characterises the wider curriculum. The induction is not a standalone event but the deliberate foundation of a vertically aligned programme in which authentic, industry-linked practice is progressively embedded from first year through to final-year capstone projects.

During the workshop, participants will experience selected activities and reflect on how simple, intentionally designed tasks can reduce uncertainty, strengthen peer connections and increase students' confidence in starting an engineering degree. Post-induction surveys indicate that 94% of respondents agreed they felt more prepared for their studies, with qualitative responses highlighting early peer connections and reduced anxiety about expectations.

References

PEE0028: Technology Demonstrator: A Modular Open-Lab Concept for Short, Self-Directed, Team-Based Engineering Practice in Higher Education

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Conference Theme: Engineering practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Poster presentation

Abstract

The Faculty of Mechanical Engineering at the University of Ljubljana has established a new practical teaching environment, the Technology Demonstrator, within a curriculum reform project under the University's initiative (ULTRA Project). The project is co-funded by the Ministry of Higher Education, Science and Innovation of the Republic of Slovenia, the European Union – NextGenerationEU, and the Recovery and Resilience Plan. The initiative responds to the growing need for stronger integration of sustainability, digitalisation, and competence-based approaches in engineering education.

The Demonstrator comprises six modular sub-units in the fields of Process Engineering, Energy Engineering, Production Engineering, Mechatronics and Laser Technology, Mechanics, and Engineering Design. Each unit allows execution of organized, short, team-based laboratory sessions centred on direct student engagement in experimentation. This approach follows established principles of active learning, which have been shown to enhance conceptual understanding and student performance compared to traditional passive instruction [1].

Preparation for laboratory work is conducted through interactive digital learning nuggets delivered via the e-classroom platform. This ensures operational readiness and allows contact time to focus on experimental execution and higher-level problem solving. During the sessions, student teams independently perform measurements and procedures, while assistants provide supervision only when necessary. The didactic structure is aligned with known experiential learning cycle, based on concrete experience, reflective observation, abstract conceptualisation, and active experimentation [2]. Reinforcement through entry and exit questionnaires further supports accountability and knowledge consolidation. Meta-analytical evidence in STEM education confirms that such active and student-centred models lead to measurable improvements in learning outcomes [3].

The poster presents the pedagogical architecture, implementation strategy, and initial educational observations of the Technology Demonstrator concept, illustrating how modular open-laboratory design combined with structured digital preparation can strengthen practical competence development and support curriculum transformation in mechanical engineering education.

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PEE029: Co-Designed Engineering Laboratories: A Practical-Based Learning Model Integrating Peer Feedback for Inclusive and Experiential Skill Development

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Conference Theme: Engineering practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Workshop

References

Practical-based learning is central to engineering education, yet first-year laboratory environments often present cognitive and structural barriers that limit equitable participation. Empirical research demonstrates that experiential and laboratory-based approaches significantly enhance conceptual understanding and professional skill formation in engineering contexts [1]. However, poorly scaffolded worksheets, implicit technical assumptions, and unclear alignment between tasks and assessment can generate unnecessary cognitive load, particularly for students transitioning from diverse educational backgrounds [2].

This interactive workshop introduces a co-designed pedagogical model that embeds structured peer feedback into the development and refinement of engineering laboratory activities to enhance inclusivity, clarity, and experiential depth. Aligned with evidence highlighting the impact of active engagement in laboratory environments [3], the model repositions students as contributors to laboratory design rather than passive recipients of instruction.

Undergraduate teaching assistants (TAs) participate in a structured review process in which they critically evaluate laboratory worksheets through a "student lens." Using guided prompts, TAs analyse clarity of language, sequencing of experimental procedures, accessibility of diagrams and datasets, alignment between instructions and assessment criteria, and potential sources of cognitive overload. Peer-review processes have been shown to strengthen evaluative judgement and disciplinary understanding in engineering education [4]. Building on this evidence, the structured "students-in-design" feedback loop enables iterative refinement of laboratory materials prior to and during delivery.

Participants will engage in hands-on worksheet analysis using a peer-informed evaluation rubric and collaboratively redesign selected components to improve transparency and accessibility. The workshop provides a transferable, scalable framework for embedding student-informed feedback loops into practical modules. By integrating structured peer review within practical-based learning, educators can strengthen technical rigour while simultaneously enhancing inclusivity, engagement, and transferable skill development in early-stage engineering education.

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PEE030: Every Third Week is a Project Week: Embedding Project-Based Learning in Early Engineering Education

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Classroom Demonstration

Abstract

This workshop/classroom-based submission describes the introduction and evolution of a project-based learning approach into the first two years of the Electrical and Electronic Engineering undergraduate programme at the University of Nottingham. The change was motivated by concerns that students were gaining strong theoretical knowledge but had limited opportunities to develop practical engineering skills early in their degree that would support a deeper understanding and provide a platform of essential skills required for completion of their final year or capstone project.

The revised curriculum combines lectures with regular periods of focused practical work. Every three to four teaching weeks, students spend a full week working on laboratory-based projects rather than attending lectures. In the first year, students work with a small autonomous vehicle platform that allows them to apply concepts from electronics, programming, sensing and control in a single system. In the second year, projects become more discipline-specific, with students working on activities related to electrical power conversion, electronic sensor systems for medical applications, and computer engineering principles for augmented and virtual reality-based engineering tools.

The projects are designed to support problem-based and student-led learning. Students work in teams to plan, build and test systems, and to connect practical results with the theory covered in lectures. Online preparation and follow-up material is used to support the practical sessions.

The workshop will outline the project based rationale, its evolution through lessons learnt and global influences. This will then be followed by a more detailed look at the structure of the project weeks, the hardware and software platforms used, and the approach taken to assessment. The aim is to provide a practical example of how project-based learning can be incorporated into an engineering programme while maintaining coverage of core technical material.

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PEE031: Bringing digitalisation into the laboratory: a Single Tube Condenser case study

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Practical Demonstration

Abstract

Automation and digitalisation are shifting chemical engineering practice from direct manipulation to supervisory control. As professional practice evolves, there is a growing need to embed digitalisation-relevant experiences within the chemical engineering curriculum [1]. Motivated by industry perspectives highlighting the importance of digital models and data-driven reasoning in early-career roles, we present a practical approach for bringing industrial digital practice into a core laboratory experiment.

Our case study is the Single Tube Condenser experiment, redesigned as a remotely operable physical rig supported by a graphical user interface (GUI) for real-time monitoring, supervisory control, and structured data recording. The redesigned setup is intended to help students develop a concrete understanding of what digitalisation means in the context of laboratory work. To highlight how digitalisation reshapes work practices, we deliver the same experiment through three staged learning environments, which include in-lab scenarios, on-site scenarios, and fully remote scenarios. By engaging with the experiment in this environment setup, we aim to help students reflect on how roles, responsibilities, and decision-making change with increasing digital mediation and why digitalisation is adopted in practice.

In this talk, we will introduce the Single Tube Condenser Experiment, show a live demonstration of the experiment setup and delivery, and provide our reflections on class usage to date.

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PEE032: Rubric grades simplification and marking scheme-feedback unification for best practice in (Chemical) Engineering Laboratories

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Conference Theme: Transformative assessment & practical work feedback	Mode of Presentation: Classroom Demonstration

Abstract

Feedback and assessment are an intrinsic part of our everyday academic role, are highly valued by our students and getting them right is of great importance. In the case of engineering or science courses with coursework in the form written reports, i.e., without exact numerical answers, in many occasions, the marks and feedback are left to the subjectivity and dedicated work of the marker, which complicates the marking or creates inconsistencies amongst markers.

In this class demonstration we present our approach to feedback and assessment and evolution undergone since AY19/20 within Chemical Engineering Laboratory 3 aiming to: 1. Minimize markers subjectivity, 2. Provide a more consistent and substantial feedback to the students throughout, 3 Reduce marking working load, and 4. Introduce more variability within the grades. This is done by implementing a Unifying Marking Scheme within the Feedback provided as well as introducing a Simplified Rubric Grades.

This is followed by a Class Demonstration example where participants will provide a grade and feedback following old feedback and assessment methodology and the new feedback and assessment implementing a unified marking scheme within the feedback sheet. The outcome of the exercise will be then quantified in terms of the grade and umber of words and examples compared with academics results. And hopefully the easiness, more straight forward, more consistent feedback and grades as well as the greater variability of the grades across two examples will be demonstrated.

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PEE033: A Virtual Site Visit to Engage First Year Chemical Engineering Students

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Classroom Demonstration

Abstract

Our undergraduate Chemical Engineering programmes include works/site visits in second year: groups of students, accompanied by a member of academic staff, travel by bus or taxi to a nearby plant. There, the group is escorted around by a knowledgeable employee who explains the process and the plant's operation on a walkthrough of the plant. Several years ago, a new chemical engineering design course was being developed for first years. We wished to give some impression of what a chemical engineering plant is like within this course, but without duplicating the physical site visits which remain in second year (and without their attendant time and cost requirements).

Hence, we developed the idea of a 'virtual site visit' using modern simulation software: the 3D Interactive Virtual Plant produced by TSC Simulation, specifically the Three-Phase Separator model [1]. The software allows an avatar to navigate through the 3D plant, emulating a physical site visit. The dynamic process simulation capabilities of the software also allow aspects of the plant to be explored that could not be in its real-world counterpart, e.g., to see what happens when a valve is closed, a setpoint is changed, or an emergency shutdown is triggered.

Rather than each student accessing the software independently, the instructor controls one instance of the simulation for reasons of practicality and cost. The instructor follows a pre-prepared route, switching between plant and control room views as required. Students watch the avatar's progress through the plant in first-person perspective on a large screen. Engagement is maintained by posing interesting questions at frequent intervals using Wooclap in competition mode. This virtual site visit was run very successfully for the first time in February 2026 in a two-hour timetable slot.

References

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PEE034: Engineering for Change: A Student-Lead Society for Sustainable-Driven Innovation Projects in Local and International Communities

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Conference Theme: Students as Practical Engineering Educators	Mode of Presentation: Poster Presentation

Abstract

Comprising 8 independent projects, Engineering for Change (E4C)[1] is an umbrella society that prioritises student-led innovation in sustainable development to domestic and international audiences. As students, we strive for entrepreneurism and delivering tangible impact to local communities while catering to their aspirations. As such, we collaborate with NGOs and industry partners in renewable energy generation to remote communities in Peru, supervise and maintain sustainable aquacultural practices – aquaponics – to food-scarce communities in Cambodia.

Aligning with the university's net-zero ambitions, E4C operates campus-level recycling initiatives like Precious Plastics which repurposes coffee cup lids into products via 3D printing and injection moulding. BioBlocks engage in lab research and experimentation of mycelium as a sustainable alternative to concrete, with development bolstered by external grants. This year, we observed substantial growth in acquiring and assembling machine parts for our drivetrain system and offshore turbines, and expanded our experimentation of processing of raw material, supporting the renewable supply chain with charities across the UK.

Our three turbine-based projects focus on developing prototypes for offshore, tide-oriented, and onshore wind, with particular attention to empowering local communities, young talent, and stakeholders during the energy transition. At E4C, we are passionate in encouraging project members to network with likeminded students internationally, demonstrable in our participation at the International Small Wind Turbine Competition by the Hanze University of Applied Sciences and representing the university at international conferences in Aberdeen [2].

Affiliated with the university's Climate Community, Sustainability Champions Network, and with 100 members from over 40 countries, nurturing members' professional and entrepreneurial talent is central to our ethos. Having recently launched our independent website alongside executing field trips to primary schools to inspire the next diverse generation of Scottish STEM talent, our individual projects received recognition through the university's Changemaker award and media recognition from the university's School of Engineering.

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PEE035: This house believes the future of practical engineering education is on digital twins coupled to virtual reality?

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Panel Discussions/Debate

Abstract

As engineering systems become more complex, interconnected, and safety-critical, traditional laboratories struggle to provide every learner with an authentic, hands-on experience. Digital twins can model behaviour in a wide variety of scenarios, and demonstrate failure modes that would be impractical, dangerous, or prohibitively expensive to reproduce in campus facilities. When coupled with virtual reality (VR), these twins become rich learning environments [1]: students can inspect assemblies at scale; and observe real-time responses to parameter changes with immediate feedback.

This proposition contends that this approach provides a rich student experience, and increases opportunity by avoiding the availability limits of experimental equipment, and enables repeatable experiences. It also aligns education with industry practice, so called Industry 4.0 [2], where digital workflows are increasingly standard. Assessment can shift from traditional laboratory reports to richer evidence of competence, capturing decision pathways, errors, and maps student exploration of the possible solution space [3]. Moreover, VR-enabled twins allow instructors to design scenarios – fault diagnosis, safety incidents, maintenance planning, or control tuning – to develop skills and build confidence for working on physical systems.

Opponents may argue that no simulation can fully replace the tactile experience, and the social learning that occurs in physical workshops. This abstract therefore frames the debate not as “virtual versus real”, but as a claim that digital-twin-plus-VR platforms will become a primary mechanism through which practical competence is developed, with physical labs complementing these.

Proposing Team:

Opposing Team:

Chair:

References

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PEE036: Learn By Doing: An Interactive Lab on Culinary Fluid Mechanics

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Classroom Demonstration

Abstract

In recent years, and particularly after the Covid-19 pandemic, it has been observed that many engineering students prefer to acquire fundamental concepts through dedicated online learning platforms rather than by attending lectures [1]. However, studying through remote platforms has been proved to negatively affect learning outcomes and exam grades [2]. Therefore, one of the lecturer's key missions is to motivate engineering students to attend and to be actively involved in classes. In this context, applied engineering courses clearly help to increase student attendance and engagement.

Here, we propose a novel interactive laboratory activity designed to explore fundamental fluid mechanics topics. The idea is to stimulate students' interest by demonstrating several fluid mechanics phenomena daily encountered in our kitchens [3]. It allows to discover the intricate physics of fluids while making coffee, cocktails, or while preparing tiramisù, or baking bread. The module includes activities with multiphase flows, complex fluids, heat and mass transfer, hydrodynamic instabilities, viscous flows, percolation, interfacial phenomena, and turbulence.

The interactive laboratory on culinary fluid mechanics has became increasingly popular over the last few years at Mines Saint-Etienne, and has received very high appreciation scores in student surveys. As a result, a shorter version of this laboratory has been also proposed to visiting middle- and high-school students to increase their interest towards scientific topics. Finally, as some of the modules are easily transportable, they have been used during thematic winter and summer schools, as well as during secondment visits at other universities.

References

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PEE037: When Bubbles Bite: A Live Interactive Exhibit for Cavitation Education

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Practical Demonstration

Abstract

Cavitation occurs when bubbles spontaneously form, oscillate, and violently collapse in a liquid subjected to rapid pressure changes. If uncontrolled, this phenomenon can cause rapid erosion and even structural failure of ship propellers, turbines and pumps. Yet its rapid jetting dynamics and small length scales make it nearly impossible to observe directly, and outside specialist research labs, it remains virtually unknown to the public.

We present "When Bubbles Bite", an interactive exhibit designed from scratch to make cavitation more relatable across a range of audiences. The centerpiece is a macroscale cavitation analogue: visitors press a large button that triggers (via Bluetooth-connected servo actuator) the bursting of a balloon underwater, producing an upward jet which is analogous to a cavitation micro-jet [1]. A high-speed camera captures the event for immediate playback on a companion tablet. Complementary displays include a cavitation-damaged ship propeller, a small tank demonstrating bubble formation around a spinning propeller blade, and an interactive web app that presents cavitation science facts through guided exploration (covering topics from bubble collapse speeds to more beneficial applications in medicine and water treatment). An undergraduate student project contributed the Bluetooth actuator mechanism, and further student projects involving image-based jet velocity measurement and bursting optimisation are planned.

The exhibit was first presented at Edinburgh Science Festival 2026 (Dynamic Earth, April) for public audiences, including families and children. At PEE26, we will demonstrate it live for an engineering education audience. We will discuss the exhibit's versatility as a teaching tool for fluid mechanics, its potential for integration into undergraduate laboratory curricula, and plans for evaluating visitor understanding and engagement across both settings.

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PEE038: A new 'backbone' for our Mechanical Engineering degree programmes

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Conference Theme: Engineering practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

This talk will present the new modules that we are developing to serve as a 'backbone' for the Mechanical Engineering programmes at the University of Edinburgh, to enhance our coverage of the skills our graduates will need for the practice of mechanical engineering in the real world.

As educators, we face the ongoing challenge of ensuring that our curricula endow our graduates with the necessary attributes for success. In recent years, as part of ongoing curriculum renewal within our School, the concept of 'backbone courses' was developed. A backbone course is a module worth one-sixth of the credits for a given year of study, and the term backbone reflects the fact that the courses act together as the central pillar of their degree programmes, forming a logical and coherent sequence. In Mechanical Engineering, our backbone courses cover topics including practical work, solution of complex open-ended problems (via the design-build-test-learn paradigm), professional issues and working in teams. The learning outcomes of these courses were specified with reference to the Engineering Council's AHEP4 standard [1] and the evolution of complexity from one year to the next was informed by the Scottish Credit and Qualifications Framework [2]. Within our programmes, the backbone courses are complemented by a strong set of courses that develop themes including (i) mathematical & computational methods, (ii) thermodynamics, (iii) fluid mechanics, (iv) structural mechanics & dynamics and (v) materials & manufacture.

References

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PEE039: Supporting student-led, self-directed learning with a new structural dynamics remote laboratory

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Conference Theme: Engineering practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Classroom Demonstration

Abstract

In this classroom demonstration, participants will interact with new, student-designed remote structural dynamics hardware and we will describe how remote laboratories can support teaching and learning across a range of learning contexts, including large-scale engineering laboratory activities. What started as a simple idea has grown into a flexible teaching tool that supports different types of experiments, such as vibration testing for system identification and modelling. The new system was first created to give students increased access to real experiments beyond what was possible in the original timetabled laboratory context. In particular, our 18 bookable remote dynamics experiments enable students to self-direct their learning; fully control their experimental procedures; and return to hardware at any stage during the extended laboratory period to confirm results, support analysis or expand their learning. The remote laboratory is designed to be used across multiple courses from Year 3 to Year 5, creating a continuous learning experience. Students return to the same system as their knowledge develops, helping them build a deeper and more connected understanding of dynamics. We will also report on student projects that involved adapting the hardware, including the addition of a tuned mass damper, demonstrating how remote laboratories can support the development of "hands-on" practical skills, creativity, and a sense of ownership. Finally, we will show how browser-based interaction with experimental hardware supports the provision of real-time formative feedback to teachers and students during laboratory activities.

References

PEE040: ACE-Lab: A Practical, Application-Led Framework for Control Engineering Education

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Practical Demonstration

Abstract

Practical control engineering education is often constrained by a disconnect between abstract theory, laboratory activities, and authentic engineering applications. This practical demonstration presents ACE-Lab, an integrated educational framework that combines the following:

- Teaching processes: ACE-CORE (Comprehend, Operate, Refine, Engineer)
- Teaching hardware labs: ACE-Box
- Real engineering applications: ACE-Apply

Learners begin with an application of interest. ACE-Apply leads this process by placing learning within an authentic engineering context, such as a self-balancing robot, pick-and-place robot, drone, or vehicle system. The selected application then determines the relevant teaching processes through ACE-CORE and the associated hardware labs through ACE-Box. The use of ACE-Box supports these teaching processes through structured exercises.

Through ACE-CORE, learners develop conceptual (through Comprehend) and operational (through Operate) understanding of control systems. A key feature of the framework is the provision of different routes through the material. An Operate-Refine pathway supports practice-first engagement with limited mathematical demand, while an Operate-Engineer pathway emphasises model-based design, i.e., mathematical modelling and simulation. The same architecture therefore supports both accessibility and technical progression. ACE-Box underpins this process through a low-cost, portable laboratory platform that supports sensing, actuation, embedded implementation, and code generation. This ensures that students develop the relevant practical control engineering knowledge before progressing to the selected application. Once the ACE-CORE and ACE-Box materials have been completed, learners should feel confident in tackling the engineering application chosen through ACE-Apply. This also gives educators access to the complete set of materials for use in their own teaching through the dedicated website, www.ace-lab.co.uk (note: the work detailed in this abstract will be completed by the time of the conference).

The practical demonstration will show how ACE-Lab brings together curriculum structure, portable laboratory hardware, and authentic engineering challenges within a coherent pedagogical ecosystem, enabling learners to progress from practical control engineering activities to application-oriented system design.

References

PEE014: What Students Really Do In Jupyter Notebooks

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Conference Theme: Transformative assessment & practical work feedback	Mode of Presentation: Poster

Abstract

Jupyter Notebooks are widely used in engineering education because they can integrate code, data, and text.[1] As a digital tool, Jupyter Notebooks can help students enact inquiry-based learning approaches during practical activities such as remote laboratory usage, e.g. where coding for data analysis, commenting, and visualization are combined. However, existing tools for providing feedback during notebook-based activities are limited. Any feedback is generally delayed until after the submission and marking are finished. The feedback is then based on the submitted version, whereas feedback on the process would be helpful if it could be provided in a timely manner.[2]

In order to fill the gap in availability of formative feedback while working in scheduled sessions or independently, we have started investigating the logging of students' interactions with Jupyter Notebooks. This includes typing, copy/pasting in code cells, comments and markdown, as well as code execution. Through analysis of this data, we hope to be able to identify patterns of student behaviour that can be used to present or derive feedback in one form or another. A related approach[3] showed that task completion rates approximately doubled when students were shown plots of their interactions with remote laboratories. Should similar benefits accrue in this case it would not only assist students in learning how to document and analyse practical work, but could also find application in other educational tasks that use Jupyter Notebooks such as coding and data analysis more generally. Our proposed approach has the advantage of addressing the scalability challenge of large cohorts of students and extending support beyond supervised hours when staff and/or peers are no longer present.

This poster will report on the study to date, including the data collection method and illustrative examples from first-year undergraduate engineering students interacting with Jupyter Notebooks during remote laboratory workshops.

References

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PEE042: Stirrer Remote Labs in Chemical Engineering Design 1

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Practical Demonstration

Abstract

Laboratory practice is paramount for the development and formation of our future graduates and engineers of the future. More in particular it furnishes our students with relevant practical and analytical skills valued in industry. Nonetheless, owed to lack of university available time, manpower and/or space resources, offering laboratory practice from Year 1 becomes challenging [1]. To counteract these drawbacks, a remote lab on a specific chemical engineering unit operation, i.e., mixing or stirring, has been developed.

In this practical demonstration, the prototype of our recently implemented Power Consumption in Stirring of Liquids remote laboratory within Chemical Engineering Design 1 [2], will be introduced. The hardware will be available for inspection and participants will also have the opportunity to interact with the software and User Interface. Participants will be able to gather data from other available remote stirrer configurations. Participants will also have access to the laboratory manual and to the experiment and assignment design [1] where the ultimate goal is for the student to apply the relevant Power number to Reynolds number dimensionalisation. Such dimensionless analysis eventually demonstrates how different configurations collapse within the same trend when applying such scaling of relevance to design and scaling up. In addition, a Jupyter Notebook exercise has been designed and implemented in Notable allowing students to plot and represent data, which will also be available for participants to try.

Although not providing hands-on practice the designed remote laboratory provides a first initial approach to laboratory experimentation and analysis as well as setting the some of the foundations for future Programming Skills course.

References

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PEE043: Remote Refrigeration Lab and Calculations App in Thermodynamics

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Classroom Demonstration

Abstract

Engineering programmes are expected to deliver high-quality, multidisciplinary, and socially relevant education to large student cohorts under constrained resources [1]. Currently, engineering programs are seeing increasing enrollments without comparable growth in space, experimental facilities and demonstrators. While lab group sizes can be increased, this limits the engagement possible for each student. By transitioning an existing piece of laboratory equipment, ET411C – Compression refrigeration system from GUNT Technology Ltd., to a remote laboratory, we have been able to offer more laboratory sessions with fewer students per session and each individual student responsible for their data collection from a unique interface. To further understand the impact of the lab activity, students complete a pre-lab analysis of a stabilized refrigeration cycle. They then collect their own data in the lab, evaluating the cycle performance from start-up to stabilization, and connect that to the exercise they evaluated before the lab to better understand the physical representation of those numbers.

In conjunction with the transition to a remote interface, we have developed a calculation app that provides instantaneous automated feedback for post-lab data processing of the remote laboratory. Prior work suggests that students often perceive report writing as a routine exercise aimed at producing a “correct” result, with limited comparison, reflection, or revision after marks are released [2]. Students also benefit from explicit support in connecting their data to underlying theory and prior work [3]. The app provides structured calculation templates, as well as results checks, and immediate quantitative feedback that supports an iterative refinement cycle.

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PEE044: LiaScript for real and virtual hardware control

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Regular: 10 minutes presentation + 5 minutes Q&A

Abstract

Teaching staff within Warwick Manufacturing Group (WMG) have been using LiaScript [1] to create and maintain course materials for multiple courses and modules due to its easily collaborative development, version control and customisation capabilities, which directly address several issues previously experienced with commercial e-learning creation software.

The ability to embed interactive content directly alongside instructional materials has been a key feature and has been well-received.

This paper discusses how the highly extensible nature of LiaScript, through its support for embedded HTML, JavaScript and therefore Web Serial [2], has enabled the creation of interactive educational materials that directly control hardware devices from within teaching materials.

The flexible nature and existing functionality have also allowed for easy repurposing of such materials for use in virtual open days for potential students, wherein multiple geographically distributed students were able to complete collaborative activities on a shared virtual CAN bus.

References

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PEE045: Project-Based Learning Through Undergraduate Research Internships

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Conference Theme: Problem-, Project- & Scenario-Based Learning	Mode of Presentation: Poster

Abstract

In this poster, my student, Nur and I reflect on undergraduate research internships at Northumbria. Since 2019, I have invited Level 5 students into my lab through 100-hour internships offered via NU Opportunities. These short projects involve real research tasks such as taking measurements, setting up equipment, and contributing to ongoing research projects. With no marks or deadlines, students feel at ease and naturally become more curious and engaged. They learn to communicate openly with PhD researchers, technicians, and me, building confidence within a real team environment. We also hold weekly informal discussions where students present their progress and explore ideas together. The experience helps students make informed choices about their Level 6 projects and think ahead into future careers. An example of a project was presented at a conference [1].

Nur shares her perspective on taking part in her first research internship during Level 5. Working in a research lab for the first time gave her a hands-on understanding of how experiments are designed and carried out, and how laboratory equipment is used in practice. Free from the pressure of grades, she could focus on genuinely engaging with the research process. The experience grew her confidence and has proved valuable in her current Level 6 project.

References

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PEE046: From student project to teaching practice: A green hydrogen generation and utilisation activity for Electrochemical Engineering Education

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Conference Theme: Students as Practical Engineering Educators	Mode of Presentation: Practical Demonstration

Abstract

Green hydrogen technologies provide an accessible route to link electrochemical engineering fundamentals with the transition towards low-carbon energy systems [1]. However, students often find electrochemical engineering easier to grasp when theory is linked to working devices [2]. This practical demonstration introduces a polymer electrolyte membrane (PEM) hydrogen energy conversion and storage activity initially led by one of our own Chemical Engineering students as part of an undergraduate research project. The activity was designed around a compact commercial 'toy' kit in which a small PEM water electrolysis cell produces hydrogen and oxygen, and the stored gases are then used in a PEM fuel cell to generate electricity [3,4].

The motivation was two-fold: to make electrochemical engineering more visible in the practical curriculum, and to create a hands-on activity through which students can apply concepts acquired in thermodynamics, transport, reaction engineering and energy systems to an industrially relevant technology. Rather than focusing on advanced theory, the demonstration emphasises what students learn by doing: assembling a safe experimental setup, measuring potential, current and gas volume, constructing polarisation curves, estimating electrical efficiency, and discussing the trade-off between hydrogen production rate, power output and energy losses.

The activity also forms part of a broader curriculum renewal. The original Electrochemical Engineering 5 [5] course is being rebalanced into Electrochemical Engineering and Energy Systems, with increased emphasis on energy conversion and storage, flowing student feedback, placements and the types of graduate opportunities students are encountering. The activity provides a bridge between taught fundamentals and emerging engineering practice: students see a complete energy-storage cycle, generate and treat real data, and appreciate why electrochemical devices must be designed not only to work, but to operate efficiently, safely and within practical constraints.

By embedding student-led development within an evolving taught curriculum, the activity illustrates how practical education can be co-created with students while connected to current research, industrial needs and the skills expected of future chemical engineers.

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PEE047: Development & pre-Evaluation of Batch Reactor Process Laboratory via Remote Access to Develop Accompanying Laboratory Skills using the ADDIE Model

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Conference Theme: Engineering practice in Higher Education & Curriculum Transformation Programme	Mode of Presentation: Poster presentation

Abstract

This study presents the development and pre-evaluation of a remotely accessible batch reactor laboratory for Chemical and Environmental Process Engineering students, designed using the ADDIE (Analyse, Design, Develop, Implement, Evaluate) instructional framework. In response to increasing demand for flexible and accessible laboratory learning, accelerated by disruptions to in-person education, remote laboratories offer a means to support engagement, contextualised learning, and skills development in engineering education [1].

The ADDIE model guided a structured yet iterative development process. During the analysis phase, a needs assessment aligned learning objectives with module outcomes. The design phase identified and repurposed an existing batch reactor system, ensuring feasibility within available resources. Development followed industrial practices, including P&ID creation, hazard analysis (HAZID/HAZOP), and system construction, alongside the integration of instructional materials linking theory to practice. Implementation began in the 2019 academic year, with ongoing refinements based on operational feedback.

Evaluation of both technical performance and pedagogical impact was conducted. The reactor produced consistent and reproducible experimental data, while student learning gains were evidenced by an increase in mean test scores from 57.67 ± 2.53 (pre-test) to 83.67 ± 5.58 (post-test). Student perceptions of usability and learning experience were also positive, indicating that remote delivery did not detract from educational value.

Overall, the findings demonstrate that remote laboratories can effectively support experimental learning and student confidence without compromising outcomes. Future work will focus on qualitative analysis of student feedback and continued iterative development of the laboratory.

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PEE048: Digital First Labsheets

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Conference Theme: Digitalisation and Artificial Intelligence in practical engineering higher education	Mode of Presentation: Poster presentation

Abstract

A labsheet is the typical method engineering educators use to provide students with all the information they need to complete their practical activities. Very often, these are created in software primarily designed to organize content around the printed page, such as MS Word or PDF. This printed page first approach is not optimized for the variety of digital displays through which students primarily consume information.

At the University of Sheffield, we are standardizing our engineering labsheets using a digital first approach. Content is authored as a plaintext file using a bespoke syntax based on markdown, which is then rendered as a web-based output optimized for a range of digital devices. Separating content from formatting ensures consistency in how information is presented and efficiently maintains inclusivity standards.

This approach is well suited to the structured nature of laboratory teaching. Health and safety briefings can be flagged with semantically meaningful callouts, ensuring critical information is presented consistently across all labs. A stepped view serves discrete chunks of information one at a time, breaking complex procedures into manageable tasks, with embedded checks (such as confirming a safety briefing has been read or a task completed) gating progress to the next step. Revealed content allows additional explanations, hints, or answers to anticipated questions to be made available on demand, supporting students who need more detail without cluttering the experience for those who do not. These features map directly onto common laboratory pedagogy: signaling critical information, sequencing student activity, and providing differentiated support.

The syntax and renderer are universally applicable to any laboratory activity, irrespective of discipline, and the full specification, alongside the renderer itself, is openly available for other educators to adopt, adapt, and extend within their own teaching.

References

PEE049: Citizen Science and Energy Literacy as Authentic Assessment in First-year Renewable Energy Engineering Students

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Conference Theme: Transformative assessment & practical work feedback	Mode of Presentation: Poster presentation

Abstract

Engineering students learning renewable energy often meet the transition as a body of concepts before experiencing it as a practical, social, and territorial challenge. This contribution presents an educational innovation being developed at the National Autonomous University of Mexico for first-year Renewable Energy Engineering students in two campuses, Temixco and Juriquilla. The project designs, implements and validates a digital platform for citizen science and energy literacy that connects classroom learning with community-based observation, data collection and interpretation. Students will work with situated problems such as domestic energy use, solar potential in public spaces, mobility patterns and energy efficiency, producing evidence, communicating findings and proposing improvements.

The project reframes practical work feedback as part of students' formation, not as a final correction. Assessment will address not only participation or content knowledge, but the capacity to link theory and practice, read data critically, recognise social and environmental implications, and use feedback to improve the quality of their explanations and decisions. This will be supported by teacher guidance, shared protocols, rubrics and a qualitative Most Significant Change approach, alongside quantitative assessment of learning and design skills.

By placing citizen science within an introductory engineering course, the project seeks to make renewable energy education more authentic, inclusive and consequential from the first semester. It also asks how feedback literacy can help students become more capable of judging their own work, communicating with non-specialist publics and designing energy solutions with social relevance. The experience offers a transferable model for practical engineering education in contexts where sustainability, equity and professional responsibility must be learned together.

References

PEE050: Remote Lab Challenge: Co-Creating the Future of Laboratory Education through Challenge-Based Learning

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Conference Theme: Transformative assessment & practical work feedback	Mode of Presentation: Workshop

Abstract

Engineering programs are expected to foster future skills that prepare students for challenges of digital transformation, green transition, and professional practice in Industry 5.0[1]. Laboratory teaching provides an important foundation for practice-based learning, as it enables students to experience and enact "doing engineering"[2] while developing these competencies. However, traditional laboratory formats are constrained by high costs, limited usage opportunities, and dependence on physical presence, limiting their flexibility and scalability[3]. Against this background, remote laboratories offer valuable opportunities for flexible, self-organised, and location-independent experimental learning, addressing the development of digital competences in engineering education. However, their implementation remains technically, didactically, and organizationally demanding, and existing remote labs are often project-based, resource-intensive, and not yet comprehensively embedded in regular teaching processes[4–6].

The Remote Lab Challenge approaches this problem from several complementary angles, combining Challenge-Based Learning with students' active involvement in the co-creative development of remote lab infrastructure. Student teams from different participating universities are asked to define problems within the context of laboratory education and develop prototypes for innovative remote experiments for learners in different educational levels, while considering their needs as well as relevant didactical structures. Rather than engaging with remote laboratories only with the perspective of learners, students take on the role of designers and critical evaluators of digital experimental learning environments. This role shift is an essential element of the transformative learning potential of the format. By moving from users of laboratory infrastructure to co-creators of remote experiments, students are encouraged to question and expand their assumptions about experimentation, learning, accessibility and digital infrastructure development. In this way, the Remote Lab Challenge links future skills development, the transformation of laboratory teaching, and the participatory development of digital laboratory resources.

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PEE051: Lego® Serious Play®: A multi-purpose tool for co-creation, design and delivery of Practical Engineering Education

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Conference Theme:	Mode of Presentation: Workshop

Abstract

In this workshop we will explore how Lego® Serious Play® (LSP) can serve us in the context of practical engineering education. Other than gaining first-hand experience of the LSP facilitated methodology, in this workshop you will have a chance to reflect on your own principles and ideas to guide co-creation, design and delivery of practical engineering courses.

This workshop has been directly inspired by my own experience in applying LSP in multiple contexts, from co-creation of Enrichment Pathways & the design of new Challenge Courses (both initiatives of the former Curriculum Transformation Programme at the University of Edinburgh) to the delivery of a LSP activity for a class of 500 first year engineering students (Engineering Principles 1), to training peer academics in the arts and the skills of Lego Serious Play (alongside the inventor of the method, Robert Rasmussen).

By building Lego models, you will undergo a transformative experience that holistically integrates mind and body (embodied cognition, Khun 2022). The "hand communication" enabled by Lego bricks is highly inspirational, and produces creative and efficient results at the same time.

LSP also is incredible shift from standard table discussion, removing student-teacher hierarchies and level the playfield, leading to meaningful conversations where the opinion of all is heard and counts equally, a foundation for co-creation and shared decision-making (Lubicz-Nawrocka & Bovill 2021).

Don't hesitate to join in this taster session!

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Extended Abstracts of the Practical Engineering Education Conference 2026

Curriculum Transformation, Student-Teacher Interactions, Problem- Project- Scenarios-Based Learning, Transformative Assessments and Digitalisation and AI

Organised by the School of Engineering at the University of Edinburgh

The Nucleus Building at the University of Edinburgh, 2 & 3 July 2026, UK

PEE001: From Molecules to Meaning: A 10-Dimensional Framework for Post-2030 Chemical Engineering Education

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Conference Theme: UN SDGs within the curriculum | Mode: 10-minute presentation + 5-minute Q&A

KEYWORDS

Chemical engineering education; post-2030 curriculum; sustainability and ethics; accreditation alignment.

ABSTRACT

The United Nations 2030 Agenda has become a major reference point for engineering education, but 2030 should be understood as a milestone rather than an endpoint [1]. Chemical engineering curricula still commonly foreground early technical competencies, such as balances, transport phenomena and unit operations, while ethics, health-safety-environment (HSE), life cycle assessment (LCA), circular economy, digital responsibility and policy interfaces are often positioned as secondary additions. This creates a mismatch between the engineers we train and the professionals societies will need after 2030: graduates who can combine technical rigour with defensible judgement in uncertain, high-stakes systems spanning energy, water, materials, food and health.

This extended abstract presents a 10-Dimensional Chemical Engineering (10D) framework as a curriculum design and audit tool for post-2030 education. The framework organises learning across three connected layers: foundational technical competence, responsible engineering systems, and societal futures. It is intended to help programme teams move beyond fragmented sustainability coverage and instead make sustainability, safety leadership, ethics, security, LCA, circularity and policy-aware decision-making visible, assessed and accreditation-aligned [2-5].

FRAMEWORK DEVELOPMENT AND STRUCTURE

The 10D framework is developed as a design-based educational model rather than as a new module list. Its core purpose is to translate the phrase "from molecules to meaning" into a coherent curriculum spine: students first learn how molecular and process behaviour can be quantified, then how engineered systems behave dynamically, and finally how engineering decisions acquire ethical, environmental, social and policy significance. Table 1 summarises the proposed dimensions and their curriculum function.

PROGRAMME AUDIT AND ACCREDITATION MAPPING

In practical use, the 10D framework can be converted into a programme-level audit and accreditation matrix. For each dimension, programme teams can identify where the relevant knowledge, skill or professional attribute is taught, practised and assessed, which assessment brief or rubric provides evidence of student attainment, and whether the learning is introduced, developed or demonstrated at an advanced level. This makes implicit curriculum intentions visible and auditable, helping to avoid the common weakness of claiming coverage through isolated lectures without clear assessment evidence.

Table 1. Proposed 10-dimensional curriculum map for post-2030 chemical engineering education.

Layer	Dimension	Curriculum function
Foundational technical competence	D1 Molecular and material literacy	Links molecular behaviour, material properties and sustainability constraints.
	D2 Mass, energy and species balances	Builds quantitative conservation reasoning across process boundaries.
	D3 Transport and unit operations	Connects momentum, heat and mass transfer to equipment and scale-up.
	D4 Reaction, separation and process synthesis	Integrates core chemical engineering design and optimisation decisions.
	D5 Dynamics, control, data and digital twins	Develops systems thinking, uncertainty awareness and digital modelling literacy.
Responsible engineering systems	D6 Ethics and professional judgement	Makes values, responsibility and evidence-based decision-making explicit.
	D7 HSE, safety leadership and security	Frames safety, risk, security and near-miss learning as leadership practices.
	D8 Sustainability, LCA and circularity	Embeds whole-life assessment and resource efficiency within design.
Societal futures	D9 Bio-based and transition systems	Prepares students for renewable feedstocks, water-energy-food links and net-zero transitions.
	D10 Policy, stakeholders and adaptive AI/digital practice	Connects engineering outputs to regulation, justice, stakeholders and responsible digital tools.

The framework also provides a coherent route for accreditation-facing curriculum enhancement. Dimensions D1–D5 align primarily with AHEP4 expectations for science and mathematics, engineering analysis, design and innovation, and with IChemE expectations for underpinning science, chemical engineering principles, engineering practice and design. Dimensions D6–D10 extend the mapping into professional formation, including ethics, HSE and safety leadership, security, sustainability, life cycle thinking, circular economy, digital capability, stakeholder engagement and policy awareness. In this way, the 10D framework does not treat accreditation as a separate administrative exercise; rather, it acts as an evidence spine linking post-2030 curriculum intent, graduate capability, assessment design and professional engineering judgement across programme levels [3–5].

EXPECTED CONTRIBUTION

The intended contribution is a transferable curriculum language for chemical engineering departments seeking to redesign programmes for a post-2030 context without diluting technical rigour. Rather than treating sustainability as a final-year topic or ethics as a compliance exercise, the 10D framework positions them as recurring dimensions of engineering judgement. The presentation will demonstrate how the model can be used to review existing modules, identify gaps, strengthen assessment rubrics and create a clearer student narrative from foundational calculations to responsible, systems-level practice.

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PEE002: Hands-On Teaching and Learning in a Complex Safety Critical Environment

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KEYWORDS

Interactive learning environment, on-site experience, civil engineering, engineering education

ABSTRACT

Students studying for a higher-level qualification in an engineering subject often do not have opportunities to gain practical experience. Engineering site experience can help to bridge the gap between theoretical classroom knowledge and real world working. Hands-on experience is highly valued by employers due to exposure to health and safety protocols, alongside a better understanding of site regulation. For a number of years, students studying for a Master's level qualification in Railway Systems Engineering have taken part in a residential experience at a heritage railway, where they have assisted with infrastructure upgrades. Research has shown that students develop a good understanding of railway infrastructure, alongside empathy for trackworkers and a greater awareness of site safety protocols.

INTRODUCTION

Gaining effective experience can be a challenge for engineering students, due to realistic projects being difficult to reproduce at a smaller scale, and access to working on operational civil engineering sites is often difficult to arrange, due to health and safety considerations [1]. Therefore, students studying for their Master's level qualification in Railway Systems Engineering were invited to attend a residential course at a heritage railway in Derbyshire, England, to gain hands-on experience of track renewals and mechanical signalling. Heritage railways are used to working with and training volunteers [2], so they have the skills set to allow students to develop railway engineering skills in a safe but real environment.

In the twelve years that this residential course has been running, students have upgraded track structure, which has included rebuilding of switch and crossing work, rail and sleeper replacement, alongside other substantial track engineering tasks (See Figure 1). As this is a heritage railway, most of the track work must be completed in the traditional manner with hand tools, jacks and shovels. Therefore, students can work on a live railway, while gaining a greater understanding of track structure and components.

Students become aware of the great risks involved in working on operational railways and learn skills to address these. They also develop a greater empathy for track workers, and an understanding of how working conditions such as inclement weather, long hours or inappropriate equipment can affect the well-being of staff and the safety of the railway as a whole.

Figure 1. Images of work being undertaken by students.

DISCUSSION

After each residential experience, students have been asked to complete an anonymous questionnaire to evaluate what they have learned and how they felt their understanding of railway engineering had developed. Feedback from students has been exceedingly positive in terms of confidence building and in gaining practical skills. The majority of students who completed the survey felt they had a greater understanding of railway infrastructure and maintenance as a result. They found the work physically tiring, but valued the teamwork aspects and the opportunities to work together on a large project. All students questioned valued the knowledge they gained from interacting with experienced railway engineers and would recommend the experience to other students.

The heritage railway team values the work students have undertaken and enjoys the interactions with students from around the world. Publicity about the students' work in the local community enhances the reputation of the academic institution and acts as outreach to encourage others to consider studying an engineering subject.

CONCLUSIONS

The heritage railway residential course has been shown to support students in developing their knowledge and understanding of railway infrastructure and maintenance. It allows students to develop a greater understanding of site safety and experience of working in a live engineering environment, alongside developing problem solving and teamworking skills. Its introduction has significantly enhanced student experience.

There are a growing number of community projects across the UK that could use volunteers to assist with renovations [3]. By implementing an approach similar to that adopted at the heritage railway, there is an opportunity for Engineering departments to give students real world experience, while visibly supporting their local communities.

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PEE003: Enhancing Students' Engagement by Innovative Experimental Approach for Problem-Solving Questions in the Foundation Year Tutorial

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KEY WORDS

Experimental tutorials, Foundation Year, group work, physics, engagement, STEM education.

ABSTRACT

This study redesigned Foundation Year physics tutorials to improve engagement and conceptual understanding. Traditional individual problem-solving was replaced with structured group work using experimental, real-world physics scenarios. Students discussed, predicted, interpreted, and linked theory to observable outcomes. Attendance data and surveys showed improved engagement, stronger conceptual understanding, and better connection between physics theory and real-life contexts, indicating that experimental group-based tutorials are an effective STEM learning approach.

INTRODUCTION

Student engagement is a key challenge in STEM higher education, particularly in Foundation Year physics, where diverse backgrounds and confidence levels can affect learning.[1] Low participation, inconsistent attendance, limited peer interaction, and requests for more interactive learning led to a redesign of traditional tutorials, replacing individual numerical problem-solving with structured small-group activities based on experimental and real-world physics scenarios.[1–3] The redesigned tutorials used structured small-group activities based on experimental and real-world physics scenarios, encouraging discussion, prediction, interpretation, and collaborative problem-solving to support conceptual understanding and STEM learning.[3–5] Group-work-based tutorials have also been shown to enhance engagement, peer learning, and retention, particularly within large or diverse cohorts.[2,6] Evaluation through survey and attendance data showed that most students reported greater engagement, improved conceptual understanding, and a stronger ability to connect physics theory with real-world and experimental contexts. These outcomes align with established student engagement models and interactive learning research.[1,6,7] Overall, experimental group-based tutorials provide an effective approach for enhancing engagement and conceptual understanding in Foundation Year physics.

METHODOLOGY

Structured group work using experimental, real-world physics scenarios tutorials were introduced in 2021/22 and further developed in 2022/23. Qualitative and quantitative data were collected through attendance records, mid-module feedback, and an anonymous end-of-term survey. The three-question survey used a five-point Likert scale to evaluate students' perceptions of engagement, learning experience, and confidence. Attendance from traditional on-campus individual problem-solving tutorials in 2019/20 was also analysed for comparison. Ethical approval was obtained from the Aston University Ethics Committee.

FINDING AND DISCUSSION

Attendance was higher in 2021/22 and 2022/23 than in 2019/20, with less decline across Tutorials 1–4, indicating improved sustained engagement (Fig. 1).

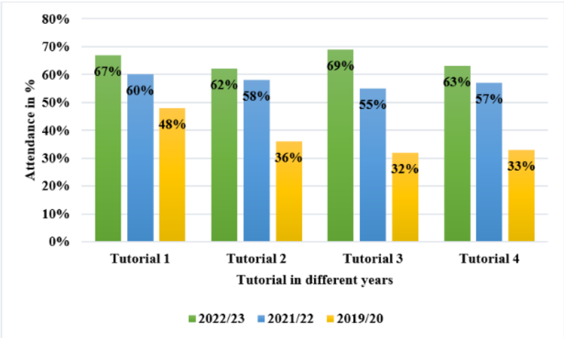

Figure 1. Attendance (%) across four tutorials in 2022/23, 2021/22, and 2019/20

Feedback shifted from neutral/improvement-focused in 2019/20 to mostly positive in 2021/22–2022/23. Monitoring and surveys showed improved learning and engagement, though some students still preferred individual work (Fig. 2).

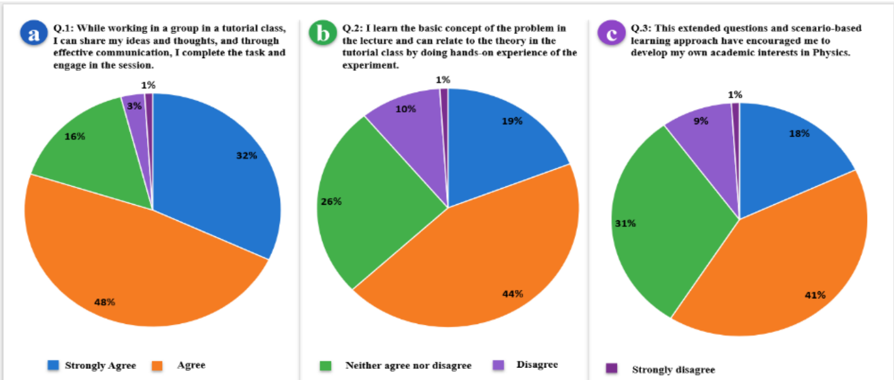

Figure 2. Pie charts showing student answers to a few key questions of the anonymous survey.

CONCLUSIONS

Experimental group-work tutorials improved engagement, attendance, and learning. Survey results showed improved engagement at 80% (Fig. 2a), concept learning at 63% (Fig. 2b), and enhanced subject knowledge at 59% (Fig. 2c), indicating an effective approach for improving participation and learning in physical science modules.

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PEE004: A Formative and Comprehensive Personalised Feedback Technique for Small Cohorts in Electrical Engineering Coursework

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KEYWORDS:

Effective feedback, coursework, performance improvement, lab report

ABSTRACT

The effectiveness of module delivery is measured by student achievement of module learning objectives. One of the measurement tools for assessing how students achieve learning outcomes is assessment. In any assessment, formative or summative, students make mistakes, and the tool for correcting them is detailed feedback that supports their learning. Rarely in higher education institutes do students receive feedback after the module's final exam. So, to enhance students' skills and ensure the achievement of learning outcomes, assignments and feedback through coursework are considered powerful tools. If feedback is superficial, learning outcomes are not achieved. This paper introduces a feedback technique for small cohorts (30-50 students) to help students overcome their learning weaknesses. As a case study, two electrical engineering modules are selected, Level 2 and Level 3. The quality of this feedback technique is assessed through statistical measures of bias and student enthusiasm. The drawback of this technique is that more time for marking and editing is required, which makes it best suited to small cohorts or groups.

INTRODUCTION

Virtual learning tools have emerged as a promising approach to enhance learning, particularly through online formative assessments combined with immediate automated feedback, which can create effective learning environments [1], [2]. While this approach offers advantages—such as suitability for objective question types (e.g., MCQs and true/false) and allowing unlimited attempts with explanatory feedback—it remains inadequate for more complex design and analysis tasks central to engineering education. Traditional feedback practices also fall short, often lacking the depth needed to meaningfully support student improvement [3]. Moreover, discrepancies persist between the intended purpose of feedback and its actual implementation, with insufficient detail limiting its usefulness; effective feedback should include clear, actionable suggestions for improvement. In response, this work proposes a structured feedback technique tailored for coursework assignments, using a spreadsheet to provide detailed marks and comments for each component, along with an overall evaluation. The method is designed around four key principles of high-quality feedback: objectivity, reliability, measurability, and specificity [3]. The paper outlines the proposed technique, demonstrates its application through a case study, and evaluates its effectiveness before concluding.

CASE STUDY

The case study describes a third-year individual assignment requiring students to design and analytically validate an engineering system, followed by verification using FEMM 4.2 software. Each student worked on a unique design derived from their ID to prevent collusion, and the task included elements beyond lectures to encourage independent learning. The assignment comprised two main problems: an electrostatic and an electromagnetic, each divided into multiple parts assessing analytical calculations, modelling skills, and interpretation of simulation results.

Marking was completed within two weeks, and feedback was delivered via Blackboard using a structured spreadsheet. This spreadsheet provided detailed marks and comments for each subtask, along with overall feedback. As illustrated in Figure 2 (an example of a failed student), the approach enabled clear differentiation among performance levels. The feedback system provides transparency across all parts, helping students identify strengths and weaknesses in their work. This structured method ensures that feedback is specific, measurable, and actionable, supporting deeper understanding and improvement.

Student name and ID [redacted]	1a		1b		1c		1d	
	Notes	Mark (/15)	Notes	Mark (/5)	Notes	Mark (/10)	Notes	Mark (/10)
	Lengthy section with multiple equations, but little or no calculations carried out. No radii, voltages are incorrect, E-field not attempted. Some discussion	4	Model is wrong	0	No plot provided, conclusions reached with no data.	0	No plot provided, conclusions reached with no data.	0
	2a		2b		2c		2d	
	Notes	Mark (/5)	Notes	Mark (/5)	Notes	Mark (/5)	Notes	Mark (/15)
	Little effort put into magnetic circuit work, but has calculated some inductance values for the circuit. Assumptions are somewhat wrong and values incorrect.	2	Question not really understood and has got a very wrong area and calculated current wrong.	3	Model is wrong	0	Has shown the flux lines for the model studied and there are results. P and Q show expected performance so must have been movement in air-gap. A correct conclusion is reached.	5

1e		Presentation				Subtotal	Final Mark	Comments
Notes	Mark (/5)	Notes	Mark (/5)			(/50)		
Charge extracted, then compared with capacitance...	1	A fairly neat report with figure labels and decent flow.	4			9	25	I think there are some serious flaws with you model setup, particularly for Q1 as there is no data to award marks to. You reach conclusions without any reason, and the report often makes little sense. However, the report is quite neat so high marks there. Unfortunately, the content of the report seriously lets it down.
2e		2f		Presentation				
Notes	Mark (/10)	Notes	Mark (/5)	Notes	Mark (/5)	(/50)		
Not sure how they calculated inductance and it doesn't agree.	2	Not attempted really	0	A very neat report given the content!	4	16		

Figure 1: Example feedback given to a failed student

CONCLUSION

This paper proposes a personalised, formative feedback technique for small electrical engineering cohorts using structured, subdivided coursework and marking rubrics. The approach delivers precise, actionable feedback, enabling students to clearly identify weaknesses and improve future performance.

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PEE007: A Multi-Stakeholder Approach to Practical Curriculum Transformation in Engineering Education

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KEYWORDS

Practical engineering education, Co-creation, Experiential learning, Curriculum transformation

ABSTRACT

Engineering employers increasingly seek graduates who can demonstrate practical competence, systems thinking, and the ability to work collaboratively in authentic contexts [1]. This paper presents a multi-stakeholder transformation of practical engineering education, led by a dedicated departmental Practical Teaching Committee since 2022. Three interconnected initiatives are discussed: systematic curriculum mapping that informed laboratory renewal; the repositioning of Postgraduate Teaching Assistants as co-educators through training and involvement in rig commissioning [2,3]; and the redesign of a final-year capstone module to prioritise design, prototyping, and skills-based assessment through two new components (designathon and prototype assessment). Internal survey data show marked improvements in student satisfaction and perceived learning experience, alongside UCL LEAF accreditation and SDG engagement [4]. The paper offers a transferable model for departments seeking to modernise practical education while strengthening employability and authentic learning.

INTRODUCTION

The first initiative was driven primarily by student voice, which served as the main precursor to a systematic review of practical learning across the undergraduate curriculum. Students engaged constructively through module evaluations and student representation, highlighting opportunities to modernise practical learning and align it with current engineering practice. This prompted a systematic mapping of practical components against learning outcomes and assessment strategies, which directly informed a programme of laboratory renewal that replaced outdated experiments and rigs with modern, pedagogically relevant systems. The investment was substantial, reflecting departmental recognition that practical competence cannot be developed through theoretical teaching alone. This mapping established a framework that module leads continue to use when proposing changes to practical content, ensuring future modifications remain aligned with learning outcomes and shaped by student voice.

The second initiative repositioned Postgraduate Teaching Assistants (PGTAs) from passive demonstrators to active co-educators within the practical curriculum, recognising their unique perspective as recent students. Historically, PGTA involvement in laboratory teaching was limited to supervising predefined experiments, with minimal pedagogical training or ownership of the content. Under the new model, PGTAs received lab-specific training materials developed in collaboration with module leads and were directly involved in commissioning, testing, and deploying new experimental rigs before these reached students. This involvement gave PGTAs genuine ownership of the design and delivery of the practical curriculum, consistent with the literature on students as partners, which emphasises that repositioning learners and near-peer educators as co-creators—rather than recipients—of curriculum content produces deeper engagement and more authentic learning for all parties [3]. PGTAs reported increased confidence, and their input during commissioning strengthened rigs ahead of live teaching sessions.

The third initiative was the redesign of the fourth-year capstone module (60 credits), addressing student appetite for a more practical, hands-on final year. The revised module shifts from document-focused deliverables to tangible products that demonstrate engineering competence, with two new summative components designed to develop practical skills and reduce susceptibility to inappropriate AI use: the designathon and the prototype assessment. The designathon is a one-week activity in which student teams develop an educational kit aligned with a module's learning outcomes, defining user needs and constructing a functional prototype (*Figure 1*b,c) supported by hand calculations. Assessment is via a panel presentation, judged on problem definition, design and build quality, and technical communication, within strict budget and material constraints, with an emphasis on reclaimed components. Prototypes have included wind tunnels and hydraulic rigs, several of which are now used as classroom demonstration kits. Despite initial scepticism, 75% felt better prepared to work within their teams afterwards. The prototype assessment, worth 25% of the module mark, evaluates how teams translate design intent into a functioning outcome, physical or software-based, using a similar panel format, with criteria that additionally cover build quality and sustainability. The prototypes also support the design process by improving design quality through iterative development. Examples include an underwater glider and a biomimetic surveillance fish. Response was overwhelmingly positive, with 87% wanting more modules to assess physical creations; several teams secured external funding, and external examiners praised the quality and industry relevance of both assessments.

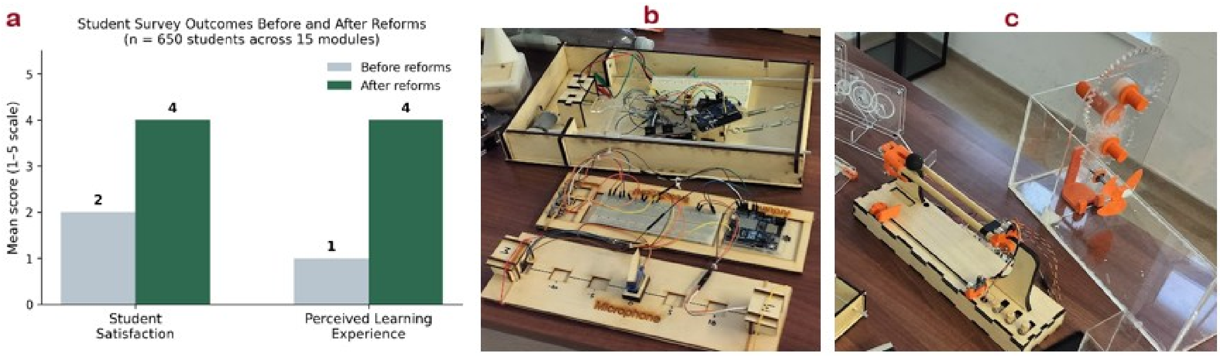

Figure 1: (a) Survey outcomes (b) & (c) Sample Prototypes

CONCLUSIONS

Across all three initiatives, internal survey data (collected annually from 650 students across 15 modules) show marked improvements (*Figure 1a*): student satisfaction rose from 2 to 4, and perceived learning experience from 1 to 4, on a 5-point scale. Sustainability has been embedded structurally throughout this transformation, evidenced by UCL's Bronze LEAF accreditation for the undergraduate teaching laboratories and explicit assessment of student engagement with the UN SDGs in individual projects [4]. This paper has shown that co-creation at scale becomes feasible when student voice acts as the catalyst for change, when near-peer educators are given genuine ownership of the curriculum, and when assessment is redesigned to reward tangible engineering output. Together, these conditions offer a transferable model for departments seeking to modernise practical engineering education while strengthening graduate employability, sustainability engagement, and authentic learning.

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PEE008: Small Measures: Practical Tasks for Teaching Statistical Process Control

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KEYWORDS

Statistical Process Control, Machine Capability, Design Tolerances

ABSTRACT

'Tolerance' (i.e., the geometric variation that a designed component will tolerate and still function satisfactorily) and machine 'capability', (i.e., the inherent geometric variation resulting from a specific process on a specific component), are terms which are regularly conflated by students, but which, whilst related, represent significantly different concepts. This paper reports on a series of practical exercises developed for the teaching of Statistical Process Control (SPC), a manufacturing technique dependent on these two constructs. The aim of these exercises was to reinforce understanding of a theoretical treatment of SPC within the same postgraduate course, and to improve the students' appreciation of the difficult demands on manufacturing that can arise from setting unnecessarily tight tolerances during the design phase.

The first exercise was based around the conducting of a 'capability study'. Statistical Process Control depends on sampling to gain a knowledge of the process output variation, and although a mesokurtic ('normal') distribution is not essential, if the distribution is known to be normal, it makes prediction of the defect rate easier. A capability study is an initial 'snapshot' analysis to establish the important parameters of the production output at a point in time. However, to teach such an 'on-line' quality technique in a practical context, it is first necessary to have some form of production line, a somewhat demanding provision for a large-cohort course. The idea was thus born of employing the students themselves in a simple manual manufacturing process, using basic equipment, to generate batches of 'components' from which samples can be taken. These samples could then be measured accurately in order to produce the capability study, which in turn provides measures of central tendency, dispersion, and kurtosis. In an industrial context, it is these parameters that indicate whether or not a production process is 'capable' of making components consistently within the required design tolerance band, subject to an acceptably low defect rate.

For the 'manufacturing process' the students were provided with lengths of 1.5mm x 1.5mm balsa strip 'stock', from which they were required to produce a batch of fifty or sixty 20mm lengths, cut using a scalpel and a steel rule. A length tolerance of +/-0.8mm was given. (This tolerance was adjusted over successive course deliveries to a level found to be challenging but attainable.) These samples were then measured to two decimal places using digital callipers. The students generally worked in pairs and were advised that one should do the cutting whilst the other did the measuring, however this was deliberately not rigidly enforced. Similarly, some students were inevitably tempted to speed up production by laying several lengths of stock next to each other and cutting multiple components at once, and were allowed to do so. Both these approaches potentially affect the output distribution, and were considered useful analogues of potential issues in industrial processes.

Once the sample data had been obtained, it was plotted on a normal probability graph, which has a non-linear horizontal scale such that a cumulative normal distribution produces a straight line. In contrast, leptokurtic (peaked with long tails) and platykurtic (flat with short tails) distributions each produce their own characteristic s-shaped deviations from a straight line. Additionally, a number of

other parameters can be read from the graph. Whilst industrial SPC software does exist, a conscious decision was taken to use a manual graphical approach based on a normal probability plot, as it was felt that the engagement this approach requires and the 'pictorial' representation of centring, kurtosis and the prediction of defect rates, was beneficial to comprehending the underlying concepts.

Sharing in class the broad range of graphs obtained, (leptokurtic, platykurtic, skewed, etc.), allowed discussion of their implications and the possible reasons behind each, but the sharing of results also had another effect; whilst the students were advised that the marking criteria were not about the quality of their process output, but rather the quality of their interpretation of the results, what was not predicted was the spontaneous 'gamification' of the exercise by many of the students, with some good-natured competition to get the best capability index. Moreover, even those who sought to reduce the chore of producing the samples without care for competing with others produced usefully illustrative examples. Specifically, those seeking to speed production by cutting several strips at once, (a change in process), inevitably produced wider distributions because of the inaccuracies this introduced, and of those pairs who chose to share cutting duties, (a change of operative or analogous to a change of machine), many produced bimodal distributions, (though some of these, as can be the case, appeared platykurtic if the peaks were not distinct). An example of a completed capability study is shown in Figure 1.

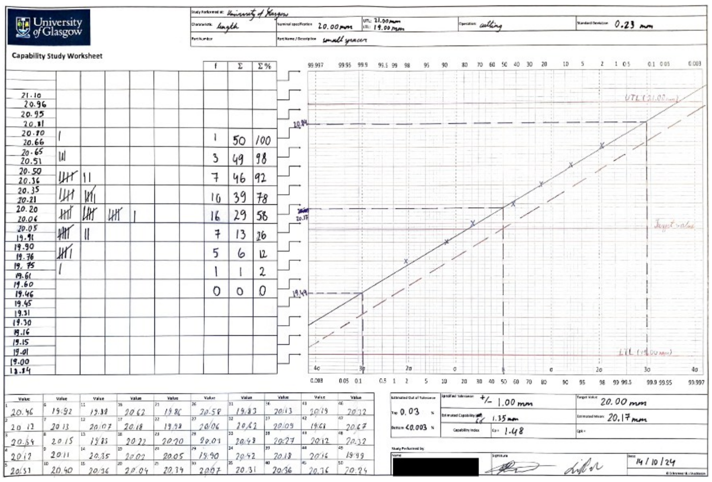

Figure 2: A completed capability study showing a mesokurtic but uncentred distribution. (Effect of centring shown dotted.)

Feedback from students was that the simple practical exercise greatly helped clarify and reinforce the theoretical concepts taught in the course lectures, and a better understanding seemed to be evidenced by the increased numbers subsequently choosing the related exam question at the end of the course. Pleasingly, it also generated requests for further practical exercises based on other sections of the course.

Opportunity for doing so arose following the recent acquisition of desk-top CNC machining facilities within the School, which has allowed the undertaking of several student projects based around production quality and the exploration of Taguchi off-line quality techniques. This in turn highlighted the scope to develop further teaching exercises for the taught course, and as a complement to the capability study, an SPC control charting exercise has been developed. The challenge for teaching this is that control charts are inherently longitudinal studies requiring production of samples over an extended period, (typically a number of hours), in order to reproduce what would happen in manufacturing industry. The insight was to make use of the large cohort, and to piggy-back the exercise onto an introduction of the CNC machines. The students are asked to work in small groups and are provided with a CNC G-code file to make a simple cuboid component, but the key is that the groups do the exercise consecutively on the same machine throughout the same day. Whilst this does present some timetabling challenges, the dimensional variation from nominal can thus be plotted over time to produce a control chart showing any drift or other pattern of change over the day.

Using such hands-on exercises has demonstrated the improved learning outcomes to be gained from students engaging physically with what are, at their core, physical concepts, and despite in some cases the very basic equipment used, has additionally improved student satisfaction with the course.

PEE011: Industrial contribution to Civil Engineering Programmes at University College Dublin, Ireland

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KEYWORDS

Active Learning, Engineering Practice, Civil Engineering, Industry.

ABSTRACT

Active learning is anything course-related that all students are called upon to do other than simply watching, listening and taking notes [1]. Hands-on activities in workshops, laboratories and in the field are perfect examples of active learning and make students aware of the practical dimension of their work. [2].

In the School of Civil Engineering, University College Dublin (UCD), a number of pedagogical approaches have been adopted to facilitate the development of the awareness of practical engineering skills and engineering practice within the curriculum. These include case studies, industrial placements, projects, industry speakers, laboratories, workshops and visits to industrial or commercial installations. The goals of this practical education include: Hands-on experience, Learning through failure, Appreciation of Civil Engineering materials, Introduction to sustainability, Fostering creativity, Working in multi-disciplinary settings, Designing innovative solutions, Working individually and in group settings, Appreciation of ethical responsibilities.

To inculcate this awareness of practice within the curriculum, the School employs a significant cohort of practitioners who make an invaluable contribution to achieving the practical competences of graduates necessary to meet the requirements of professional accreditation. This short presentation will describe how the contribution of practitioners is integrated across the various stages of the programmes in a cohesive manner to better prepare students for the workplace. The challenges of embedding practical engineering within the programmes, for example, health and safety, timetabling, assessment etc. that need to be addressed to produce programmes that integrate theory with practice to achieve the desired learning outcomes will be discussed.

A key pedagogical approach in achieving the learning outcomes listed above is involving industry and professional practitioners in all stages of the curriculum. For example, industrial practitioners are brought onto campus to instruct students, as shown in Fig. 1 and conversely students are brought off campus on site visits facilitated by industry, as shown in Fig. 2.

Figure 1. Leica Geosystems instructing UCD Civil Engineering students on the Total Station Theodolite.

Figure 2. UCD Civil Engineering students on a site visit to Glenman Construction.

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PEE0018: Experiential Learning in Thermal Management: A Progressive Practical Teaching Approach to Bridging Theory and Industry Competence in Engineering Education

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KEYWORDS

Experimental learning, progressive teaching, practical competence.

ABSTRACT

Engineering employers increasingly seek graduates who can demonstrate practical competence, systems thinking, and the ability to work collaboratively in authentic contexts [1]. Meeting this expectation requires practical teaching that moves beyond procedural laboratory exercises and engages students in structured experiential learning cycles that connect theoretical knowledge to real-world applications [2]. This paper reports a two-year scaffolded, experiential teaching intervention in heat transfer to measurably improve knowledge retention, student satisfaction, and perceived learning experience — offering a replicable model for engineering programmes seeking to strengthen skills development and graduate employability through progressive practical curricula. It discusses the pedagogical rationale, design principles, and lessons learned, offering a transferable model for embedding experiential learning in thermal sciences and related engineering disciplines.

INTRODUCTION

The global push towards decarbonisation and sustainability, combined with the increased use of cloud computing and artificial intelligence, necessitates effective thermal management. From large-scale shell-and-tube heat exchangers to small-scale computer chip heat sinks, a hands-on understanding of heat transfer principles and approaches is essential not only to design a thermal management system but also to maximise cooling capacity and efficiency. In response to this, an experiential learning cycle (Figure 3) that progressively builds students' practical competence over two years of the undergraduate programme was developed.

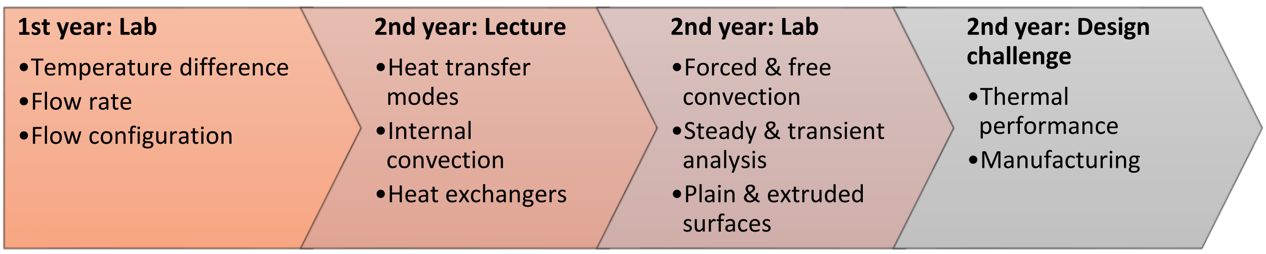

Figure 3. Experiential learning cycle

In the first year, students gain hands-on experience with concentric tube-in-tube and plate heat exchangers, exploring the effects of temperature difference, flow rate, and flow configuration on overall heat transfer performance. This prepares students for 2nd year lecture content on heat transfer modes, internal convection and heat exchangers. Building on this foundation, the 2nd year lab gives students hands-on experience by investigating forced and free convection across flat, pinned, and finned surfaces. Overall, this learning cycle broadens their awareness of heat exchanger types, as well as their understanding of design trade-offs for different engineering contexts.

RESULTS

Anonymous surveys were conducted for both the 1st and 2nd year labs, and Figure 4 indicates that 71% and 91%, respectively, of the students reported that the labs were excellent in facilitating comprehension of the theoretical contents taught. For both labs, the students reported that they enjoyed the hands-on experience, being able to adjust parameters themselves, record the data, and visualise it on graphs. The 1st-year lab was followed by an individual online quiz, that tested basic theoretical concepts and calculations. Students performed well, with an average of 87%, confirming their basic understanding of heat exchangers before going deeper into the theoretical principles in the 2nd-year module. The 2nd-year lab was followed by a group lab report in which they evaluated and compared the performance of different surfaces, taking into consideration the trade-off between temperature uniformity and velocity distribution. Again, the students performed well with an average of 84%, confirming their understanding of heat exchanger design principles.

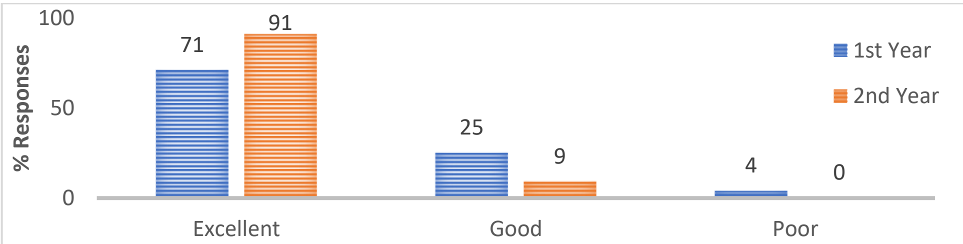

Figure 4:Student feedback on the extent to which the lab facilitates comprehension of theoretical concepts.

Student feedback indicated that the 2nd-year lab can be improved by reducing waiting periods for steady state conditions. Furthermore, because the lab report results were generally high, the lab's emphasis was shifted from procedural tasks to critical thinking. This will culminate in an authentic design-and-build assessment, in which students design their own heat sink, which will be manufactured and tested, and which also fills gaps during the lab session while waiting for steady-state conditions. This process contributes to developing applied decision-making skills demanded by industry [3], and applying their heat transfer knowledge to thermal management. Furthermore, it allows for greater grading depth within the marking rubric, especially in distinguishing first-class students from other students who mastered the procedural tasks and theoretical concepts.

CONCLUSIONS

Aligned with the student feedback, the assessments confirmed improvements in knowledge retention and learning experience across both years. Students enjoyed the hands-on experience and being able to investigate the effects of a variety of parameters, heat transfer surfaces, and heat exchanger types on the overall thermal performance. This emphasises that experiential, programme-level practical teaching produces stronger graduate competencies than isolated laboratory exercises.

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PEE020: Designing for Density: Scaling Active, Student-Executed Laboratories in Large-Cohort Engineering Programmes

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KEYWORDS

Active learning, engineering laboratories, large cohorts, practical education

ABSTRACT

Delivering active laboratory experiences to large engineering cohorts is challenging, with demonstrator-led experiments often limiting student participation. This work presents an alternative approach in which laboratory activities are designed around student execution while remaining scalable. The approach was implemented across three first-year mechanical engineering laboratories: jet impact (fluid mechanics), heat exchanger (heat transfer) and refrigeration (thermodynamics). Rig provision was increased from five to nine across the three laboratories, reducing group sizes from up to 18 to approximately six students. Postgraduate Teaching Assistants (PGTAs) shifted from a demonstrative to a facilitative role, supported by on-rig instructions, while the number of PGTAs remained unchanged at six. An anonymous survey of 391 students found that 97% rated the laboratories as Good or Excellent for supporting theoretical understanding, including 80% selecting Excellent, while PGTA engagement was rated 4.7/5. The findings demonstrate that student-executed laboratories can be delivered successfully at scale, increasing student interaction with equipment without increasing PGTA staffing.

INTRODUCTION

Laboratory teaching plays a central role in engineering education by enabling students to connect theoretical concepts with physical systems and develop experimental competence [1]. However, increasing student numbers and limited rig availability often result in delivery models in which demonstrators operate the equipment while students primarily observe. Although efficient from a staffing perspective, this approach reduces opportunities for active participation and experiential learning [2].

This work explores an alternative philosophy for large-cohort laboratory design: maximising student interaction with equipment while maintaining scalability through structured activities and PGTA facilitation [3].

The approach was implemented within the first-year Mechanical Engineering Practical Skills module (MECH0004) at University College London.

LABORATORY DESIGN FRAMEWORK

The redesign was applied to three first-year laboratories: jet impact (fluid mechanics), heat exchanger (heat transfer) and refrigeration (thermodynamics), each 1.5 hours long. Previously, the heat exchanger and refrigeration laboratories used two rigs each and jet impact a single rig, giving group sizes of approximately nine and eighteen students. As PGTAs largely conducted the experiments, student feedback indicated low student engagement.

Rig provision was increased to three per laboratory, reducing group sizes to approximately six. Each rig was equipped with step-by-step instructions enabling students to progress through the laboratory independently - operating equipment, taking measurements, analysing data and comparing results with theoretical predictions - with PGTAs facilitating: assisting students who encountered difficulties, responding to their inquiries, and engaging them with questions during steady-state waits. The self-sufficient nature of the on-rig instructions meant that a single PGTA could oversee multiple rigs simultaneously; despite increasing rig numbers from five to nine, the number of PGTAs required remained unchanged at six.

DEVELOPMENT OF ENGINEERING SKILLS

The redesigned laboratories develop experimental planning, safe equipment operation, teamwork, data acquisition and analysis, interpretation of uncertainty, and the ability to connect theoretical models with real engineering systems.

This approach encourages students to develop confidence in experimental practice while reinforcing material taught in lectures and professional engineering judgement.

RESULTS

An anonymous end-of-module survey (n=391) found that 97% of respondents rated the laboratories as Good or Excellent for supporting their understanding of theoretical concepts, comprising 80% Excellent and 17% Good, with PGTA engagement rated 4.7/5. Qualitative feedback consistently highlighted the value of hands-on experimentation, increased confidence and stronger connections between theoretical concepts and physical systems. Further evidence of engagement was provided by an optional design challenge in which students designed and 3D-printed custom vane geometries for testing on the jet impact rig: 12 students submitted over 20 designs, compared with no uptake of the same opportunity the previous year.

CONCLUSIONS

This work demonstrates that large-cohort engineering laboratories can be made highly active without a proportional increase in staffing: increasing rig provision and shifting PGTAs to a facilitative role allowed group sizes to fall substantially, with PGTA numbers remaining unchanged, while also supporting conceptual understanding and skill development.

Rather than treating equipment density as a fixed resource constraint, the proposed approach reframes it as a pedagogical design variable: increasing rig availability, paired with a facilitative PGTA role and self-sufficient on-rig instructions, allows more students to interact directly with experimental systems without increasing staffing requirements. The strongly positive student responses suggest that this framework provides a practical and transferable model for scaling active laboratory education across engineering programmes. The winning vane design from the optional challenge will be manufactured in aluminium and used in next year's jet impact laboratory - a tangible outcome of the student engagement the redesign produced.

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PEE023: Reinforcing Practical Engineering Education Through an Early-Engagement Research Lab Model

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KEYWORDS

Undergraduate research experience, Open-access research lab, volunteer-to-intern pathway.

ABSTRACT

Engineering education has traditionally been regarded as a predominantly *"hands-on"* discipline, rooted in applying theory to real-world problems through laboratory and workshop activities. This work presents a new educational initiative, currently in its first academic year, that complements programme laboratory teaching in Mechanical Engineering and Energy & Environmental Engineering through an open-access Research Lab. As the lab is still being established, students actively contribute to its development by designing experimental setups, receiving training in experimental techniques, numerical modelling, and laboratory practice, and participating in research project workshops.

INTRODUCTION

In recent years, global developments such as the COVID-19 pandemic, the widespread adoption of remote work, and the increasing use of artificial intelligence have accelerated a shift away from face-to-face teaching toward online and hybrid learning environments. This shift has, in some cases, been accompanied by reduced student engagement and attendance, as well as challenges in sustaining staff motivation. As a result, the nature of the "hands-on" experience offered in universities has been significantly affected, particularly in disciplines such as engineering, where practical, team-based activities are central to learning [1]. The concept of *"hands-on"* learning itself is increasingly contested. Traditionally associated with laboratory experimentation and physical interaction, *"practical learning"* is more broadly defined as the application of knowledge to real-world challenges across a range of settings [2]. Consequently, many engineering professionals now argue that activities such as computer modelling, simulation, and coding should also be considered forms of experiential, practice-based "hands-on" learning. Ultimately, the key challenge lies in identifying the skills engineering students need to develop to enhance their employability. Research in the UK highlights the importance of embedding both technical and transferable skills, such as problem-solving, teamwork, and interdisciplinary thinking, within engineering curricula to better prepare graduates for the workplace [3].

The *open-access Research Lab* initiative enables a range of activities that help students develop broader skills in scientific communication, presentation, teamwork, and research writing, thereby supporting their academic and professional growth. This approach is supported by evidence showing that structured, hands-on experiences, such as undergraduate research and internships, significantly enhance the technical competence, confidence, and academic development of engineering students [4,5,6]. A central component of the initiative is the *Volunteer-to-Intern pathway*, which enables students from early years to join ongoing research alongside early-career researchers. Students may enter the *Research Lab* at any stage of their degree and progressively build skills, with the potential to continue developing them through the final-year projects. Typically, students begin as volunteers, gaining experience and confidence; as their engagement deepens, some may progress to paid internship roles supported by internal or external funding. Early instances of volunteer withdrawal highlighted the importance of structured onboarding and sustained mentoring, consistent with findings in the literature on effective undergraduate research environments [4,6]. This initiative will reinforce and supplement practical learning in programme laboratories, particularly as scheduled lab provision becomes more constrained, by offering additional opportunities to apply and extend structured skills to open-ended research problems. This strengthens conceptual understanding, enhances practical capability, and supports the development of engineering judgement and professional identity, outcomes strongly associated with undergraduate research experiences [5].

PRELIMINARY RESULTS

Preliminary results from the first academic year indicate that a total of eight undergraduate students volunteered to participate in the Research Lab: one first-year student, two second-year students, four third-year students, and one final-year MEng student. Among these participants, only two were undertaking their final-year honours projects within the Lab. Most students engaged actively in the organised training sessions during the first trimester. However, a noticeable decline in participation was observed during the second trimester. Apart from the final-year project students, only two participants, a first-year and a second-year student, remained actively involved, and both have since progressed to “intern” roles within the initiative.

Working with undergraduate students requires a significant investment of time. Despite high levels of commitment and motivation among students, academic staff involved in the Research Lab are not always able to provide sustained, close supervision due to competing demands. Financial constraints also represent a major limitation. Institutional support for undergraduate internships is currently limited, and external funding bodies do not always consider undergraduate students as suitable candidates for research funding.

Although it is still too early to draw conclusions, initial observations indicate that participating students are gaining valuable experience. Students have the opportunity to attend weekly meetings alongside early-career researchers and are developing a broad range of skills. These include technical, research, and transferable competencies such as communication and teamwork. In addition, students are beginning to contribute to research outputs and play an active role in supporting the development and sustainability of the *open-access Research Lab*.

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PEE024: Co-Solving of Non-Hypothetical Problems to Facilitate Innovation: Student Perceptions and Performance

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KEYWORDS

Problem-based learning, authentic assessment, student partnership, industry-facing assessment

INTRODUCTION

Authentic assessment remains central in engineering higher education, yet recent literature has questioned whether the term has become too elastic to offer reliable design guidance [1,2]. Co-solving of non-hypothetical problems responds to this by organising teaching and assessment around genuinely unresolved problems, with students, academics and external stakeholders as joint contributors to inquiry, decision making and delivery. We report data from a second-year engineering module at Harper Adams University across four years as this approach is introduced.

FRAMEWORK

The framework has four interdependent elements. *Co-solving* treats students as partners, with responsibility for interpreting the problem and defending design decisions [3]. *Non-hypothetical problems* are real, messy, open-ended, and with no predetermined solution often share wicked characteristics [4]. *Facilitation* describes a pedagogic approach which is not to transmit content, but to structure and guide student self-learning [5]. The desired output is *innovation* as students use authentic tools, data and environments to produce work that is new to the partner organisation.

RESULTS

The results span two iterations of a previous approach and two of the new. Both iterations share the same format with open briefs, group working, and a design review with invited engineering professionals, and differ only epistemically. The earlier project was constructed for the module with a known solution; the new is a genuine unresolved challenge aligned to university research priorities.

Design review group marks are reported (2022/23 and 23/24 under the previous approach, n = 9 and n = 10 groups; 24/25 and 25/26 under the new approach, n = 11 and n = 8); and an anonymous online questionnaire administered to the current cohort individually after assessment (n = 11).

Performance: Year-on-year variation within each approach was statistically indistinguishable (Figure 1). Pooled mean group marks rose by a statistically significant 8.9 percentage points from 48.6% under the previous approach (n = 19) to 57.5% under the new (n = 19). The proportion of groups achieving ≥60% rose from 11% to 42%, while the proportion below 40% fell from 26% to 11%. Variance also tightened in 25/26, suggesting more consistency as scaffolding for the new approach matured.

Perceptions: Student perceptions were strongly positive across most measures (Figure 2) although the most strongly endorsed items speak to features not specifically attributable to a non-hypothetical problem. With regards the open nature of the problem itself, free-text responses recurrently emphasised pride and significance, identifying the independence of the approach as the source of "a lot more pride" in their work. Only 55% felt their workload was more manageable than in other modules, with qualitative responses calling for clearer expectations and scheduled checkpoints; partly an inevitable consequence of replacing a constructed problem with an unresolved one.

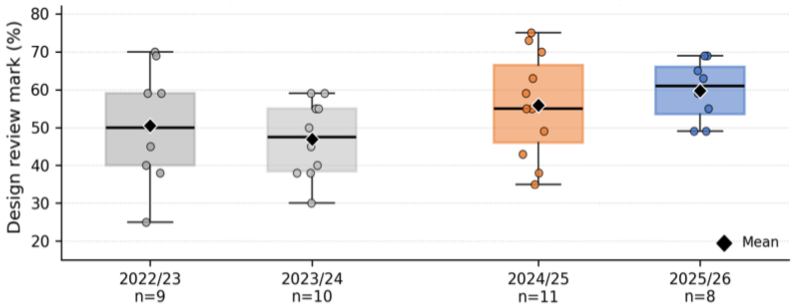

Figure 1. Student marks grouped by approach. Diamonds mark means, points are individual groups. Within-approach year-on-year differences are not significant (within previous: Welch's p = 0.55; within new: p = 0.46); the pooled between-approach comparison is significant (Welch p = 0.029; Mann–Whitney p = 0.049; Cohen's d = 0.74).

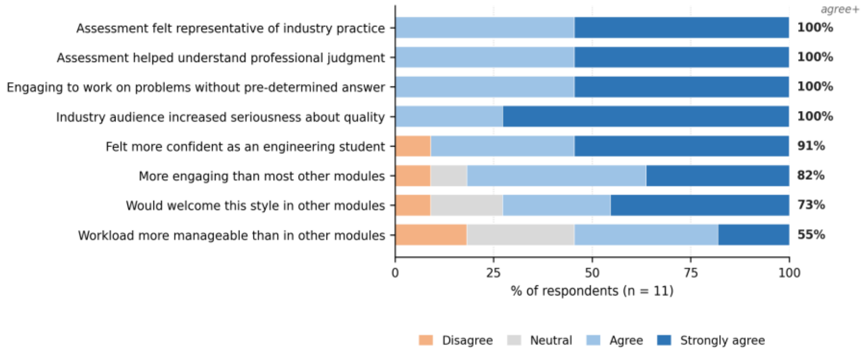

Figure 2. Distribution of agreement on selected Likert items from the post-module questionnaire. The right column shows the proportion agreeing or strongly agreeing (agree+).

DISCUSSION

The performance analysis suggests the improvement is attributable to the change in approach rather than to cohort or marker drift, however the qualitative picture is more nuanced. The cohort that produced substantially better assessed work, and spoke with markedly increased pride about it, did not attribute their experience to the unresolved nature of the problem itself despite this being the only substantive change, with only 27% agreeing that the lecturer's not knowing the answer affected their motivation. The operative mechanism may lie in changes to the facilitator stance, partner engagement, and the absence of an implicit "right answer" experienced by students as a change in *atmosphere* rather than in *epistemic status*.

CONCLUSIONS

The co-solving framework produced measurable improvements in both attainment and student experience, distinct from the "authentic assessment" style the previous module already exemplified. Students did not explicitly attribute these gains to the unresolved problem itself, motivating further work on how the framework's elements interact.

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PEE026: Experiments ReLOADed and enLITEened

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KEYWORDS

remote labs, accessible experiments, kinematics, simple harmonic motion, circular motion.

INTRODUCTION

Laboratories are traditionally aimed at involving students in an iterative, active-learning approach which accelerates transfer from theory to practice and hence improves engagement and outcomes [1]. A review of remote labs [2] suggested that while initial results are promising in terms of educational outcomes, more rigorous evaluation is still needed while another study [3] suggests that the way in which Remote Labs are introduced, directly influences engagement and resulting learning outcomes.

Created in 2000, at the University of Leeds, ReLOAD (Real Labs Operated At Distance) has been delivering experiments to UG students locally, nationally and internationally for ¼ century [4]. The "Distance" in ReLOAD, can be anything from millimetres to thousands of kilometres, with students accessing video, graphical and raw data, 24/7 from a phone, tablet, laptop or PC, via a web interface. In 2025-26, so far, it has delivered circa 60k experiments to over 1.2k students, mainly in the UK and China, from a menu of over 200 experiments. In addition to access, students are also able to submit results from initial calculations within the lab, allowing real-time feedback for students and staff.

In level 1, UG mechanical engineering students, typically study dynamics and kinematics, building on work within the Physics A level curriculum. Through our interactions with level 13-14 teachers, this part of the curriculum was identified as an area where more or better physical experimentation, may improve learning outcomes for students. We describe here how remote lab equipment was built to address this need using ReLOAD and its use within a workshop to demonstrate future usage.

METHODOLOGY

Using students interns as co-creators, Level 1 lab equipment was analysed and improvements were identified. Design criteria were agreed and 3 kinematic examples were selected to show how circular motion is converted into linear motion. These are Scotch Yoke, Crank Slider and Quick Return. Through various design iterations, prototypes were built in-house, using readily available components and processes. Following initial testing and refinement, 10 of each were built and used in 2 level 1 modules, in a) Leeds and b) Chengdu. In both modules, equipment in Leeds was accessed through ReLOAD and students used the equipment predominantly in timetabled lab classes, Equipment was also available after these sessions to allow greater accessibility. Results from initial calculations submitted within the lab, helped identify and correct common or individual errors within the session.

RESULTS AND DISCUSSION

The design process for the Crank Slider mechanism, from the original manual commercial device, to 1 of the 10 copies of the final design compatible with ReLOAD and used in the current study can be seen from left to right in figure 1. 2 crank radii are available with differing crank lengths and variable operating speeds possible via the ReLOAD interface. A stepper motor and 2 encoders were chosen to actuate and measure the response of the mechanism.

Initial testing using the ReLOAD system to collect data on each of the 10 mechanisms is shown in figure 2. The relationship between angular and Liner displacement is seen in figure 2 (left) showing 2 distinct sets of data, one with a crank radius R and the other 2R. Figure 2, (mid left) shows the variation in R (manufacture tolerances) and in angular velocity ω (mid right) due to measurement accuracy. Variance from an optimal harmonic wave is also shown also shown in Figure 2 (fight)

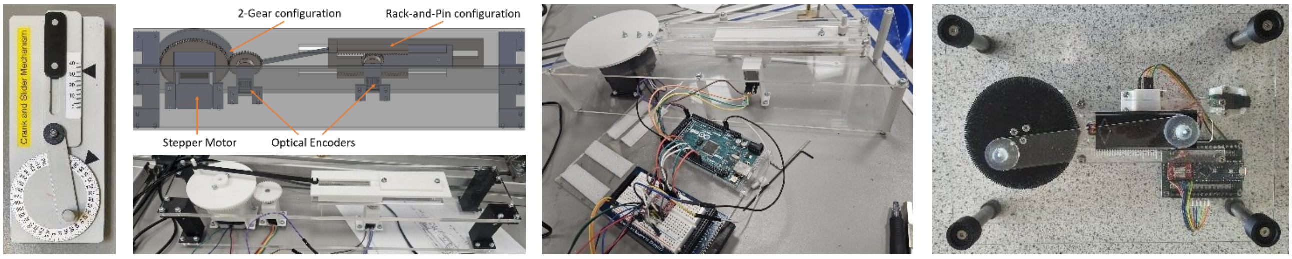

Figure 1, Left - original equipment, Mid - initial to final prototypes, Right - ReLOADed device

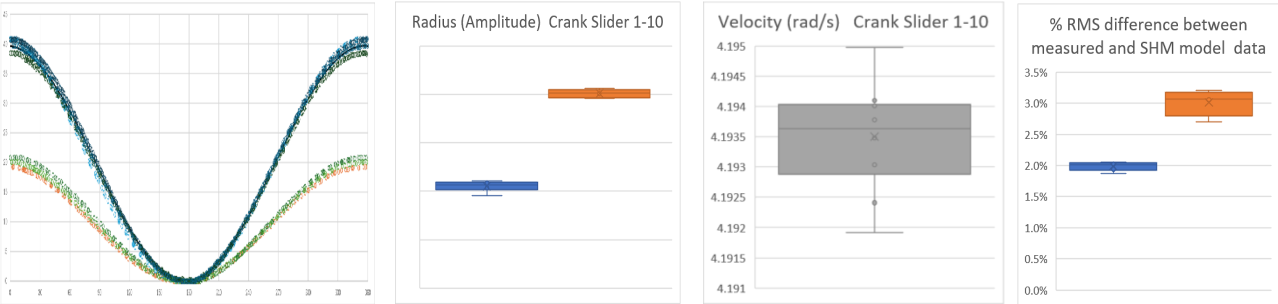

Figure 2 Left - captured data, Mid - variation in R and ω, Right - comparison with harmonic model

Evaluation data in Figure 3, shows that while most experiments in Leeds (green) and China (red) were requested on the timetabled days, during allocated hours, significant number of requests were also received outside these times and days (blue), demonstrating the utility of improved access.

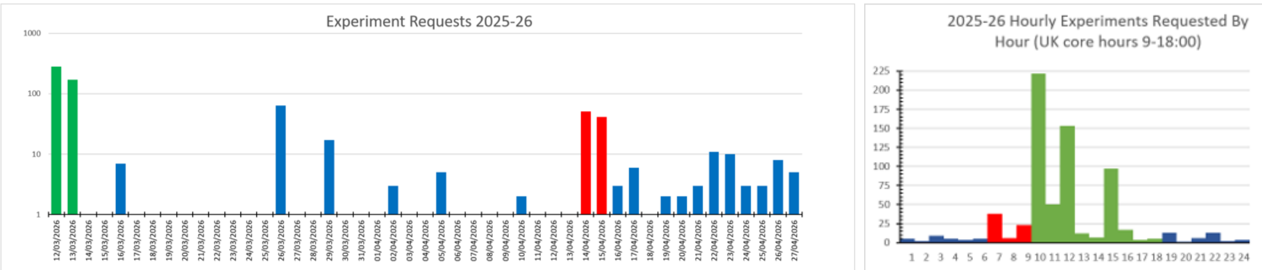

Figure 3 Left - usage data by day, Right-by hour. Leeds (green) China (red) Mixed (blue)

CONCLUSION

Via a workshop, supported by The Leeds Institute for Teaching Excellence (LITE) and the Footsteps Fund, we can demonstrate a way in which ReLOAD could support year 12-13 students who are interested in practical activities, but lack resources for appropriate experimental enquiry. Participants will take part in collaborative experiments focused on Simple Harmonic Motion and its link to Circular Motion using kinematic equipment, experiencing how real-time feedback is delivered.

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PEE027: Induction as the First Engineering Project: Designing for Confidence and Belonging

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KEYWORDS

Induction; programme design; confidence; belonging; engineering education

ABSTRACT

This paper presents a redesigned two-day induction for Mechanical and Automotive Engineering students at Northumbria University, framed as the first act of deliberate programme design rather than an administrative necessity. Specific activities are chosen to build confidence, establish peer connections, and reduce environmental uncertainty before the curriculum proper begins. Post-induction survey data from 81 students provides supporting evidence, with 94% agreeing they felt more prepared for their studies and 86% reporting feeling welcome.

DESIGN

Induction is routinely treated as an administrative necessity. The design described here starts from a different premise: that the first two days are the curriculum's opening move, and that the choices made in that space directly shape whether students develop the confidence, belonging, and environmental familiarity that later learning depends on. Students who arrive uncertain about expectations, unfamiliar with the environment, and without peer connections are less likely to engage, regardless of capability. Early social and academic integration predicts persistence [1], and belonging in the first weeks is associated with retention and attainment, particularly for students from non-traditional backgrounds [2]. The Northumbria Mechanical and Automotive Engineering induction is structured around four elements, each chosen for a specific purpose.

Programme Welcome. Common to most programmes, and the one element here that sits outside the activity-based design of the wider curriculum. It is retained because some content, programme expectations, assessment structures, professional identity, cannot be established any other way. The intent is to make explicit what is often left tacit, so that familiarity with how the programme works is not a proxy for prior advantage [3].

Scavenger Hunt. Students work in small teams to solve clues located across laboratories, IT rooms, teaching spaces, and common areas. The explicit goal is campus familiarisation; the underlying purpose is to reduce the environmental uncertainty that compounds early anxiety through active problem-solving rather than a guided tour.

Icebreaker Activities. Structured around negotiation exercises, estimation challenges, and team design problems that mirror the lectorial approach of the wider programme. These establish norms of participation and collaboration before formal teaching begins.

Personal Tutor Lunch. An early introduction to the personal tutor who will support students throughout the programme through structured, regular meetings tied to professional development milestones and assessed learning outcomes.

Taken together, the four elements are a designed whole rather than a sequence of discrete events. Each contributes to a shared purpose: that students leave induction with a clearer sense of what they are doing, who they are doing it with, and that they are in the right place.

EVIDENCE

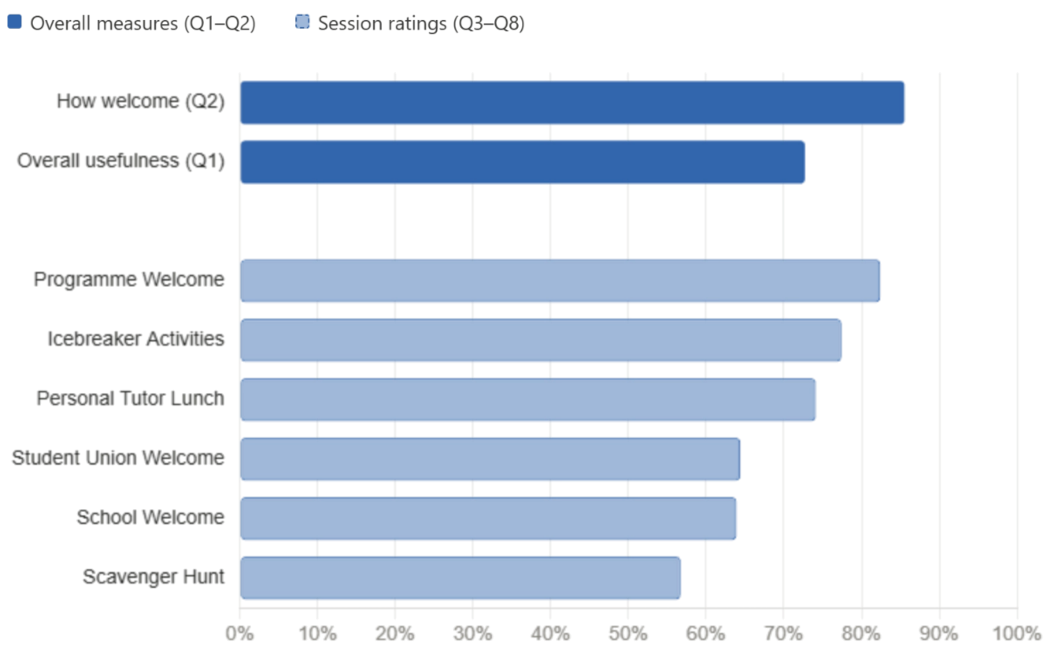

Figure 1. Post-induction survey results: % of students selecting a positive response on a four-point scale. Q1–Q2: n=76–77. Session ratings (Q3–Q8): n=58–68, excluding "not applicable" responses.

A post-induction survey was administered to 81 students at the end of induction week, using four-point Likert items on overall usefulness and session-level ratings, a binary preparedness item, and open questions. Of the 70 who responded to the preparedness item, 66 (94%) agreed they felt more prepared for their studies. Of 76 who rated their sense of welcome, 65 (86%) responded positively (Figure 1).

The Programme Welcome and Icebreaker Activities were rated highest at session level (82% and 77% positive respectively). The Scavenger Hunt was lowest (57%), with qualitative responses suggesting a more structured campus orientation might serve some students better. This is a useful finding: the activity had an explicit purpose, so the data points clearly toward a redesign. That kind of evidence-informed iteration is only possible when the design was intentional in the first place.

Qualitative themes from the most useful session question mapped directly onto the three design intentions: orientation to expectations (*"it gave me an overview of how things will go throughout the year"*); social integration (*"I got to know people in the class which helped me to feel more comfortable when I started"*); and environmental familiarity (*"the scavenger hunt showed you around the campus and that's what is most important to a new student"*).

Confidence and belonging are not individual attributes that students either arrive with or do not. They are structural outcomes of the environment students enter. Induction is part of that environment, and it can be designed accordingly.

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PEE030: Every Third Week is a Project Week: Embedding Project-Based Learning in Early Engineering Education

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KEYWORDS

Project-based learning, transferrable skills, engineering curriculum design.

ABSTRACT

Engineering graduates are increasingly expected to demonstrate transferable competencies such as teamwork, communication, problem-solving, adaptability, and practical technical capability alongside disciplinary knowledge. To address concerns that students were developing strong theoretical knowledge but limited practical capability during the early years of study, the University of Nottingham redesigned the first two years of its Electrical and Electronic Engineering programme around a curriculum-level project-based learning (PBL) framework. This paper describes the rationale, implementation and outcomes of embedding dedicated project weeks throughout the curriculum. The approach integrates technical learning with authentic engineering practice through structured laboratory projects, redesigned assessment and reflective activities. Early evidence indicates improvements in student engagement, confidence and preparedness for advanced engineering design work.

INTRODUCTION

Traditional engineering curricula have been highly effective in delivering theoretical knowledge but often provide limited opportunities for students to develop practical engineering skills and transferable competencies during the early stages of their degree. Industry increasingly expects graduates to demonstrate teamwork, communication, project management, problem-solving and adaptability alongside technical expertise.

To address this challenge, the Electrical and Electronic Engineering programme at the University of Nottingham adopted a curriculum-level project-based learning strategy. Building on previous developments in practical engineering education, the curriculum was redesigned to embed practical and professional skill development throughout the first two years of study while maintaining coverage of core technical content. The objective was to create a scalable and sustainable model that better prepares students for advanced design projects, employment and continuing professional development.

RESULTS

The redesigned curriculum interleaves conventional lectures with dedicated project weeks occurring every three to four teaching weeks. During these periods students focus exclusively on laboratory-based project work. First-year students use an autonomous vehicle platform developed in-house to integrate concepts from electronics, programming, sensing and control. In the second year, projects become more discipline specific, including activities in power electronics, medical sensing systems and computer engineering applications.

Transferable competencies are intentionally embedded within project activities through teamwork, competition, communication exercises and reflective practice. Supporting online resources and small-group learning sessions encourage self-directed learning and application of theory within authentic engineering contexts.

Assessment was redesigned to place greater emphasis on practical competence through demonstrations, viva voce examinations, presentations and project documentation (Table 1). Student feedback has highlighted increased engagement, confidence and practical understanding. Industry engagement has similarly indicated improved relevance to professional engineering practice. The approach also demonstrated resilience during adaptation to remote and hybrid delivery following the COVID-19 pandemic.

Table 1. Changes to Year 1assessment as a result of changing pattern of study post COVID-19 pandemic.

Assessment Type	**Pre-Covid Weighting**	**Current Weighting**	**Key Learning Outcomes**
Technical Writing	60%	30%	Literature evaluation, technical problem solving, system integration, data analysis, scientific writing, and wider engineering context.
Project Logging	10%	10%	Project planning, self-directed learning, teamwork, leadership, and reflective practice.
Individual Viva Voce	10%	30%	Practical skills, equipment use, measurement and analysis, iterative design understanding.
Group Presentation	5%	10%	Communication of engineering solutions, societal context, risk awareness, software tools
Individual Poster	15%	n/a	n/a
Practical Demonstration	n/a	20%	Delivery of a functional solution to a complex engineering problem

CONCLUSIONS

Embedding project-based learning at curriculum level has enabled the development of practical engineering capability and transferable competencies alongside disciplinary knowledge. The structured project-week model provides repeated opportunities for students to apply theory, develop professional skills and engage in authentic engineering problem solving. Early evidence suggests improved student confidence, engagement and preparedness for advanced study and employment. The approach provides a sustainable and scalable framework for engineering education that can be adapted across programmes seeking to strengthen practical and professional graduate outcomes.

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PEE032: Rubric grades simplification and marking scheme-feedback unification for best practice in (Chemical) Engineering Laboratories

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KEYWORDS

Laboratory Reports, Marking Simplification, Consistent Feedback, Decrease Marking Load

ABSTRACT

Feedback and assessment are an intrinsic part of our everyday academic role, are highly valued by our students and getting them right is of great importance. In the case of engineering or science courses with coursework in the form written reports, i.e., without exact numerical answers, in many occasions, the marks and feedback are left to the subjectivity and dedicated work of the marker, which complicates the marking or creates inconsistencies amongst markers. In this classroom demonstration we present our simplified and unified approach to grades and feedback aiming to: 1. Minimize markers subjectivity, 2. Provide a more consistent and substantial feedback to the students throughout, 3 Reduce marking working load, and 4. Introduce more variability within the grades.

INTRODUCTION

Chemical Engineering Laboratory 3 (CEL3) [1] yearlong laboratory course is assessed via 100% coursework and each of the laboratory sessions is assessed via a different type of assignment, varying from written reports to presentations. In the case of CEL3 written reports, marking schemes and feedback are typically divided into different descriptors: Presentation, Abstract, Introduction, Theory and Apparatus, Results, Discussion, Conclusions, and Sample Calculations. And each descriptor receives individual grades and feedback, which allows students to clearly relate the mark and feedback for each specific section of their report. An example of the feedback sheet provided to students including the different descriptors for AY19/20 and AY24/25 are found in Figure 1.

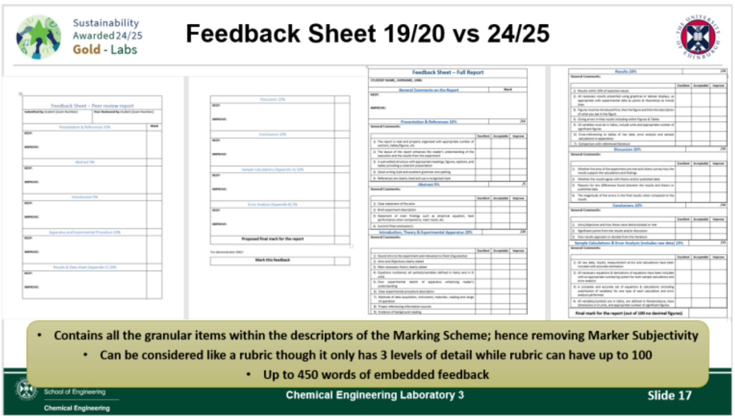

Figure 1. Example of the Full Report feedback sheet in (left) CEL3 AY19/20 and (right) CEL3 AY24/25. Note the more specific of the items to be tackled within each descriptor and the 3 levels of rubric grades available: Excellent, Acceptable and Improve, while additionally providing 450 words of embedded feedback.

RESULTS

Participants to the classroom demonstration will be provided with the Full Report Abstract submitted by one our students in AY22/23 (shown with permission), either Example 1 or Example 2. These Abstracts had been also marked by the corresponding academic in AY22/23 (for later comparison). Participants will then mark, either Example or Example 2, making use of the former (AY19/20) and the current (AY24/25) CEL3 Marking Scheme and Marking. Figure 2 includes the sheets provided to the participants for Example 1 embedded with the former (AY19/20) in Figure 2(left) and current (AY24/25) CEL3 Marking Scheme and Marking Sheet in Figure 2(middle).

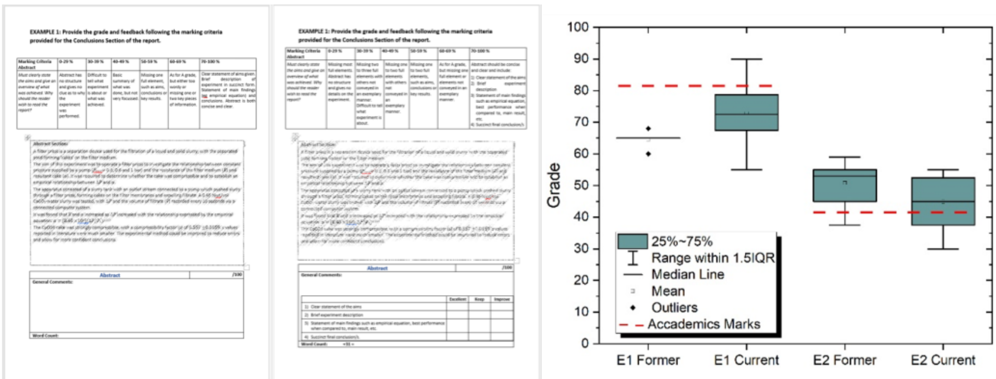

Figure 2. (Left & middle) Example 1 containing the Abstract from a Full Report, Marking Scheme and Feedback provided in CEL3 AY19/20 and in CEL3 AY24/25. (Right) Box plot including grades, for Example 1 E1 and Example 2 E2 making use of Former (AY19/20) and the Current (AY24/25) CEL3 Marking Scheme and Marking Sheet where dashed red horizontal lines show the actual grade given by the academic.

Participants will be given 5 minutes (in line with the time given to academics) to read the Marking Scheme and the Abstract and to provide the grade and written feedback anonymously; first making use of former (AY19/20) and then current (AY24/25) procedures. Upon completion, the grades provided for each example will be averaged and standard deviations calculated for both Example 1 and Example 2 as in Figure 2(right). In addition, the number of words will also be compared.

Preliminary results presented in Figure 2(right) show the greater variability of the grades between 75 and 45 when using current (AY24/25) procedure opposed to 65 and 55 making use of former (AY19/20) when comparing Examples 1 and 2. Moreover the grades reported via current (AY24/25) procedure approach those of the ones given by the academics [2].

CONCLUSIONS

We expect to demonstrate the effectiveness of the proposed rubric grades simplification and marking scheme-feedback unification for best practice in (Chemical) Engineering Laboratories. On one hand, to confirm the expected increase in grades variance accounting for a more realistic outcome of the students' marks/work. While on the other hand, establish the more substantial and specific of the students' feedback in terms of granularity/itemised of the feedback provided. Findings reported could benefit other courses/disciplines with coursework assessment and feedback.

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PEE034: Engineering for Change: A Student-Lead Society for Sustainable-Driven Innovation Projects in Local and International Communities

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KEYWORDS

Student-Led Innovation, Energy Transition & Sustainability, Renewable Energy, Aquaculture, Community Development, International Development Projects, Social Impact Engineering.

ABSTRACT

Engineering for Change (E4C) is an umbrella society comprised of eight independent student-led initiatives across the School of Engineering, spanning renewable energy, sustainable materials and international development. Bringing together students from more than 40 countries, E4C provides students opportunities to design, prototype, and implement engineering solutions in collaboration with industry partners, NGOs, and local communities. We are represented at the university's 15-year Regenerative Sustainability Strategy Launch event [1] and are affiliated with the Sustainability Champions Network [2] and the university's Climate Community group.

RENEWABLE ENERGY INNOVATION

Our two wind turbine projects Wind Over Waves and Winds of Change are centred on the independent design and development of floating wind structures for offshore wind, integrating various simulation and programming software including Python and OnShape. Both projects are actively commissioning sustainability reports for prototypes and perform design reviews testing the electrical and mechanical safety systems. Winds of Change routinely participates at the International Small Wind Turbine Competition [3] by the Hanze University of Applied Sciences in the Netherlands, networking with global universities, professors, and industry professionals for feedback. Our turbine projects have also previously been awarded development grants by Siemens.

Tide Tech seeks to realise a sustainable solution to the energy needs of small island developing states (SIDS) through the manufacturing of tidal turbines, utilising the university's world-leading wave simulation tanks at the FloWave Ocean Energy Research Facility [4]. A winner of the RS Student Fund, the project now looks towards expediting the development and manufacturing of the drivetrain system and blades.

INTERNATIONAL COMMUNITY ENGAGEMENT

Reflecting our commitment as global changemakers, each summer, our three international projects seek to apply and deliver engineering solutions to food and resource insecurity. Spanning three continents, our projects foster students' professional development, applying both engineering knowledge and soft skills to real clients. Project Peru travels to Lobitos, northern Peru, to support electrification and water identification and access efforts, while Project Cambodia liaises and maintains our aquaponics system – a soil-less farming method – to lessen food insecurity for rural communities, establishing lasting connections with partners. When stationed, project members install a new family-scale system, conduct essential maintenance, and refine designs to address malnutrition and promote self-sustaining farming practices. All international projects ensure local community involvement and contact with their specific NGO throughout the year.

CAMPUS-BASED CIRCULAR ECONOMY INITIATIVES

Based in the school's award-winning chemical engineering labs, Precious Plastics repurposes used coffee cup lids into merchandise for local businesses, aligning with university recycling targets. We vastly expanded our operations in the past year to include dedicated 3D printing, injection moulding, and outreach departments, gaining media recognition from the School of Engineering and winning the university's Changemaker award [5]. Moreover, the project recently partnered with Ghost Fishing [6] to source recyclable materials and routinely chairs workshops and careers fairs in schools throughout Edinburgh to empower STEM education.

BioBlocks engages in academic and lab research of mycelium mushrooms as a sustainable alternative to concrete. The team lets the mycelium grow on an organic substrate, forming root networks that can later be baked, compressed, and used as construction blocks. In the past year, the project acquired a development grant with Kew Gardens [7], which funded the implementation of optimised growth chambers and designing a cylindrical rebar framework to support mycelium growth.

Our newest project, WattWheels, seeks to harvest electrical energy from the rotational motion of gym equipment, with the aim of affixing the technology to other gym equipment, including treadmills and stair climbers.

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PEE036: Learn By Doing: An Interactive Lab on Culinary Fluid Mechanics

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KEYWORDS

Interactive laboratory, experiential learning approach, culinary fluid mechanics.

ABSTRACT

In the past years, it has been observed that many engineering students prefer to acquire fundamental concepts through dedicated online learning platforms rather than by attending lectures [1]. This is also the case for fluid mechanics courses at Mines Saint-Etienne, particularly after the Covid-19 pandemic. However, studying through remote platforms has been proved to negatively affect learning outcomes and exam grades [2]. This has prompted the author in conceiving an interactive laboratory on culinary fluid mechanics, aiming to enhance participation and learning by letting students apply fundamentals of fluid dynamics to prepare their favourite food.

INTRODUCTION

This interactive lab, launched for the first time during the academic year 2023-2024, follows an experiential learning approach, for which learners need encounter, observation, conceptualization and experimentation [3]. Here, students are first exposed to fluid dynamics phenomena and theoretical instructions, and then engage themselves in experience by applying theory to culinary preparations [4]. Indeed, by making coffee or cocktails, and by preparing cakes or bread, the module includes activities with multiphase flows, complex fluids, heat and mass transfer, hydrodynamic instabilities, interfacial phenomena, and turbulence. By continuously breaking theoretical instructions through practical culinary experiences, this interactive lab motivates students to be actively engaged and thus deepens the understanding of a such complex subject.

RESULTS

An anonymous survey composed of six statements on a 5-point Likert scale was delivered to the students who attended the interactive lab on culinary fluid mechanics in the academic year 2025-2026. One of these questions dealt with the overall appreciation of the interactive lab. The responses shown in the top bar of Figure 1 have been compared to survey responses to the same question (although based on a 4-point Likert scale) for a traditional course on multiphase flow at Mines Saint-Etienne during the past five academic years (bottom bar). This last course was taught by the author of this article together with another instructor, as it covered a broader range of topics. However, comparable satisfaction scores reported in parallel surveys suggest that this does not significantly bias the results. The analysis reveals a significant improvement in overall student satisfaction when practical cooking experiences are offered. In particular, with a mean of 4.86 and a median of 5.0, the results show a higher appreciation for the interactive lab course method with respect to the traditional multiphase flow course, which scores a mean of 4.27 and a median of 4.0. Furthermore, Figure 2 shows the results of the remaining five statements (listed in the caption), which could not be compared to the traditional course due to lack of equivalent questions. While the satisfaction for the interactive lab compared to other courses is clear (Q1 and Q5), as both the cooking experience and the teaching strategy effectively support learning (Q2 and Q3), such an interactive lab has room for improvement in attracting interest towards sustainable food and food waste (Q4).

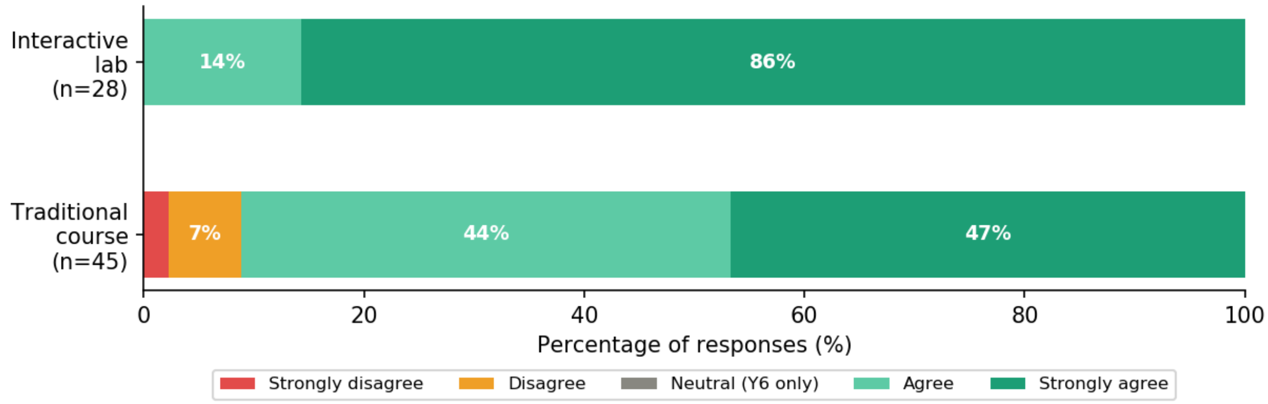

Figure 1. Responses to the statement ''Overall, I am satisfied with the course'' for the interactive lab on culinary fluid mechanics (top bar, n=28 answers for the academic year 2025-2026) and a traditional course on multiphase flow (bottom bar, n=45 responses for the past five academic years 2021-2026).

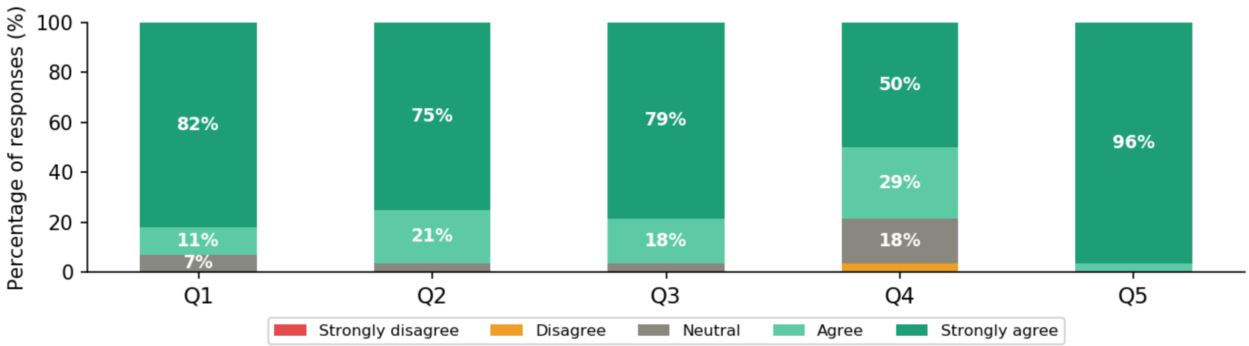

Figure 2. Distribution of responses to stand-alone survey questions for the interactive lab (n=28 answers for the academic year 2025-2026). Questions are labelled Q1 to Q5 according to the following list. Q1: Compared to other courses with traditional teaching this semester, I found this interactive lab more valuable for my learning. Q2: The cooking experiments support well the learning objectives. Q3: The instructor effectively explained concepts and supported my learning. Q4: This course help me reflect on food sustainability, homemade meals, control on ingredients and cooking processes. Q5: I would recommend this interactive lab to other students.

CONCLUSIONS

In this work it has been shown that following an experiential learning approach on topics that are part of everyday life (in this case the culinary arts) helps catching student engagement and interest, with a 14% increase in mean satisfaction score compared to traditional courses (Figure 1). Furthermore, the cooking experience has shown to effectively support the learning objectives (Figure 2). As a result, a shorter version of this interactive lab has been also proposed for scientific outreach activities and to visiting middle- and high-school students to increase their interest towards science.

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PEE037: When Bubbles Bite: A Live Interactive Exhibit for Cavitation Education

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KEYWORDS

cavitation; public engagement; interactive exhibit; fluid mechanics pedagogy

ABSTRACT

Cavitation, the spontaneous formation, oscillation, and violent collapse of vapour bubbles under rapid pressure change, is responsible for erosion and structural failure of ship propellers, turbines, and pumps. Its microsecond dynamics and sub-millimetre length scales make it nearly impossible to observe directly, and it remains virtually unknown outside specialist research labs. We present *When Bubbles Bite*, an interactive exhibit built to make cavitation physics tangible across public and student audiences. The exhibit walks visitors through a consequence-to-cause arc across four hands-on stations: a wireless-throttle mini-propeller tank in which visitors drive a miniature propeller and observe cavitation themselves, a cavitation-damaged metal ship propeller they can pick up and inspect, a visitor-triggered submerged-balloon burst whose high-speed recording, replayed in slow motion, is broadcast on a wall-mounted monitor immediately after, and a self-paced tablet app that extends the experience and logs engagement. The exhibit was presented at Edinburgh Science Festival (ESF) 2026 and will be demonstrated live at PEE26. We report the design rationale, formative evaluation data from ESF, and plans for integration into undergraduate teaching.

INTRODUCTION

Cavitation is a canonical topic in fluid mechanics, yet is rarely taught hands-on: the relevant phenomena occur too quickly and at too small a scale for a classroom tank, and high-speed imaging rigs are confined to research laboratories. Students and the public encounter cavitation mainly through static diagrams in textbooks or short video clips. Both routes sacrifice the most pedagogically useful feature of the phenomenon: the causal link between pressure fluctuation, highly asymmetric bubble collapse, and the high-speed jet, which is the typically unseen cause of cavitation erosion. We set out to build an exhibit that restores this link, live, repeatable, and accessible to audiences.

EXHIBIT DESIGN

The exhibit is staged as a participatory process. A ~15 cm diameter balloon is submerged in a clear bench-top tank fitted with a needle; the presenter hands a wireless detonation button to a visitor (typically a child), then counts down with the other visitors, and on the button press, a synchronised high-speed camera (500 fps, 1 s window) captures the collapse. The recording is then broadcast to a large monitor behind the bench, where the slow-motion jet is replayed for all of the visitors, turning a sub-millisecond event into a shared spectacle. If a burst is unclear, the demonstrator can fall back to a pre-saved recording from earlier. A bubble machine on the bench draws in younger visitors.

The balloon analogue is mathematically motivated. A bursting submerged balloon produces a gravity-driven asymmetric jet of the type described by Supponen et al.'s [1] anisotropy framework for single collapsing cavitation bubbles. The jet reproduces the qualitative asymmetric-collapse signature that damages real propellers, at a length scale roughly three orders of magnitude larger which can be easily observed. Two further stations close the loop to engage visitors (while also allowing buffer time for our volunteers to reset the balloons). A small tank houses a wireless-throttle mini-propeller (with a child-friendly cruise-control mode) that visitors can operate themselves, watching the clouds of hundreds of thousands of bubbles typical of real applications. A real ship propeller visibly pitted by cavitation erosion, sits at hand for visitors to lift, feel, and inspect (under a magnifying glass) the damage that thousands of cavitation bubbles leave behind.

A self-paced online app supplements the bench, its interface designed to resemble an underwater environment. Twelve question cards arrive in two waves of six (the second wave is unlocked after the first), letting visitors browse cavitation facts at their own pace, with optional "dive deeper" external links and an exit survey capturing prior knowledge, takeaway, surprise, intent, and age band. The app's primary roles are evaluative – it logs every visit anonymously – and pacing: it occupies the inevitable queue wait, and between demonstrations or during camera changeovers its screen is mirrored to the rear monitor to keep the bench's focal point alive.

FORMATIVE EVALUATION: ESF 2026

The app logged anonymous session-level telemetry (question taps, dive-deeper link taps, second wave unlock, survey responses). Useable data covered the final two festival days (12–13 April 2026), comprising 26 logs from a public family audience that skewed strongly under-10 with some teenagers. Of these, 14 logs (54 %) registered at least one question tap, with a median engaged-session duration of 4.8 minutes. Figure 1 summarises the findings.

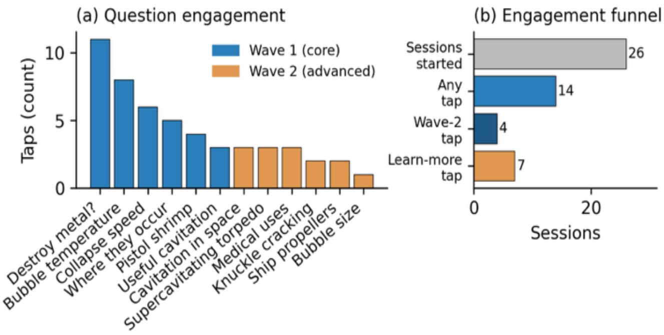

Figure 1. Formative evaluation from ESF 2026 (N = 26 logs). (a) Question-card taps by wave (blue Wave 1, orange Wave 2). (b) Engagement funnel from session start through Wave-2 and learn-more taps.

The destruction framing dominated: the "Can bubbles destroy metal?" card attracted 11 taps, a third more than the next-most-tapped Wave 1 card (bubble temperature, 8 taps). Two confounding variables explain this: the card ordering within the app, and the cavitation-pitted propeller visible at the adjacent station. The "Can orange juice pop a balloon?" video embedded in it was the single most-followed external link, accounting for four of nine learn-more taps. Wave-2 reach was smaller (4 sessions, with space-cavitation, torpedos, and medical uses tied at 3 taps each), and only two surveys returned. A passive exit survey is insufficient for this setting and no responses were received; for PEE26 we will use a brief post-visit feedback form (paper and online) alongside telemetry, comparing ESF and PEE engagement patterns.

CONCLUSIONS

When Bubbles Bite shows that a participatory four-station tour around a macroscale balloon analogue makes cavitation physics accessible to first-time audiences. At PEE26 we will outline a route to undergraduate curriculum integration (potentially via a third-year laboratory module).

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PEE040: ACE-Lab: A Practical, Application-Led Framework for Control Engineering Education

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KEYWORDS

Hands-on Learning, Control Engineering, MATLAB and Simulink, Model-Based Design (MBD)

INTRODUCTION TO THE ACE-LAB

Practical control engineering education is often constrained by a disconnect between abstract theory, laboratory activities, and authentic engineering applications. This practical demonstration presents ACE-Lab, an integrated educational framework that combines the following:

- Control system application type
- Teaching material through ACE-CORE
- Required ACE-Lab equipment

Using the Bitesize Scaffolding Framework, learners begin by selecting the control system application type of interest, see Figure 1. The available applications are arranged in order of increasing complexity; for example, **Proximity Detection and Collision Warning** represents a relatively straightforward control-system application, whereas **DC Motor Speed Control** is considerably more advanced.

Learners then select the teaching material through ACE-CORE, see Figure 1, with this given by the following four levels:

1. Comprehend (C) focuses on understanding the control-system problem by identifying the system requirements and developing the structure of the control-system block diagram. This stage establishes the system architecture before any implementation takes place.
2. Operate (O) focuses on implementing the control system using the ACE-Lab platform, integrating sensors and actuators, and validating and verifying that the system satisfies its specified requirements.
3. Refine (R) focuses on improving the performance of the implemented control system via the ACE-Lab by adjusting controller parameters and validating and verifying that the system satisfies its specified requirements.
4. Engineer (E) focuses on the use of a model-based design approach, validating and verifying that the system satisfies its specified requirements, before deploying the solution onto the ACE-Lab hardware.

The selected application determines the ACE-CORE teaching processes that are available. For introductory control-system applications, only Levels 1 (Comprehend) and 2 (Operate) are available, reflecting the scope of the associated learning activities. Figure 1 illustrates an example in which DC Motor Speed Control has been selected, enabling progression through all four ACE-CORE levels (Levels 1 – 4).

As ACE-CORE is centred on the operation, analysis, and refinement of applied control systems, linked to the ACE-Lab equipment, see Figure 1. The ACE-Box builds on the author's previous work on Control-Lab-in-a-Box (CLB), which was developed to bridge the gap between control theory and practical implementation [1, 2]. The original CLB was initially designed around an automotive vehicle application [3]. ACE-Lab is a low-cost, portable laboratory platform that supports sensing, actuation, embedded implementation, and automatic code generation for deploying on real hardware. This enables students to develop practical control engineering knowledge and skills within a selected application domain of interest.

Based on the selected control system application type and ACE-CORE, the corresponding learning resources are generated and made available in multiple formats, including HTML and PDF, for educators and learners to download. Relevant MATLAB and Simulink files are also made available for download. For the required ACE-Lab equipment, several options are available, including the instructions to 3D print this yourself and purchase the required electronic parts. The implementation details of this resource generation process are beyond the scope of this paper.

All teaching materials/tools are accessible through the dedicated ACE-Lab website (www.ace-lab.co.uk), providing educators with a central platform for resources.

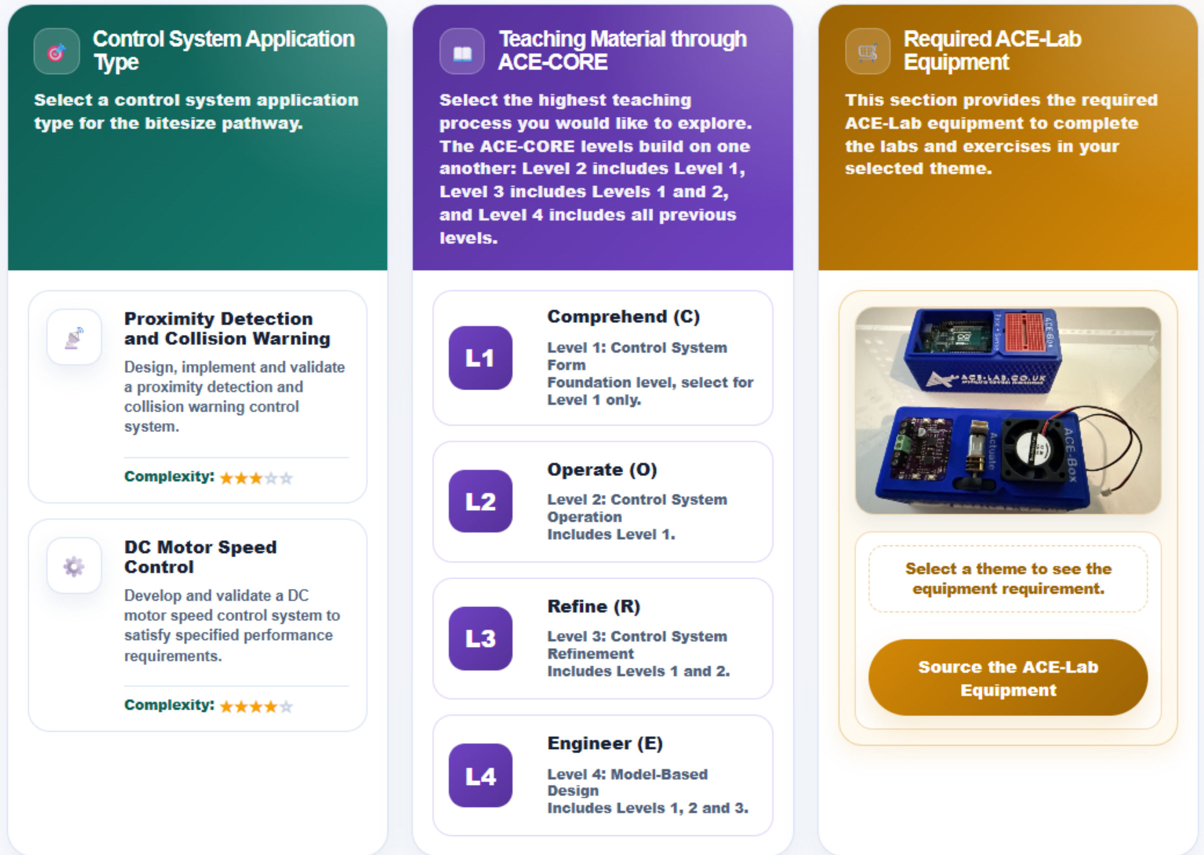

Figure 1. The Bitesize Scaffolding Framework

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PEE042: Stirrer Remote Laboratories in Chemical Engineering Design 1

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KEYWORDS

Remote Laboratories, Power Stirring of Liquids, Dimensionlisation in Design, Scaling-up

ABSTRACT

Laboratory practice is paramount for the development and formation of our future graduates and engineers, furnishing our students with relevant practical and analytical skills valued by industry. In particular, remote laboratories develops an awareness of modern methods for remote plant operation, complements in-person labs, and also has the benefit of being efficient on university time and resources. In this demonstration, a remote laboratory on a chemical engineering unit operation, i.e., mixing or stirring of liquids, has been developed and implemented within Chemical Engineering Design 1 (CED1) [1], which is a Year 1, 20 credits, 1 Semester long course assessed 50% via coursework and 50% via exam. Within the coursework component 10% weight is given to reporting the experimental results via Notable/Python while 30% weight is assessed via a laboratory report.

INTRODUCTION

Stirring of liquids plays an important role on many industrial and everyday applications where mechanical agitation is required. From stirring our tea or coffee in the morning to enhance the mixing and homogeneity of the drinks (batch), to fermentation processes in water treatment, bioreactors, food and beverage industry, and/or polymerisation and refining in petrochemical industry; either in batch, semi-batch or continuous mode.

In this practical demonstration, we introduce the prototype of our recently implemented Power Consumption in Stirring of Liquids remote laboratory within Chemical Engineering Design 1 [1], shown in Figure 1(left). Eight-duplicated different configurations contain a range of paddle heights and number of paddles, as shown in Figure 1(middle) and two different working fluids. The hardware will be available for inspection and participants will also have the opportunity to interact with the software and User Interface shown in Figure 1(right).

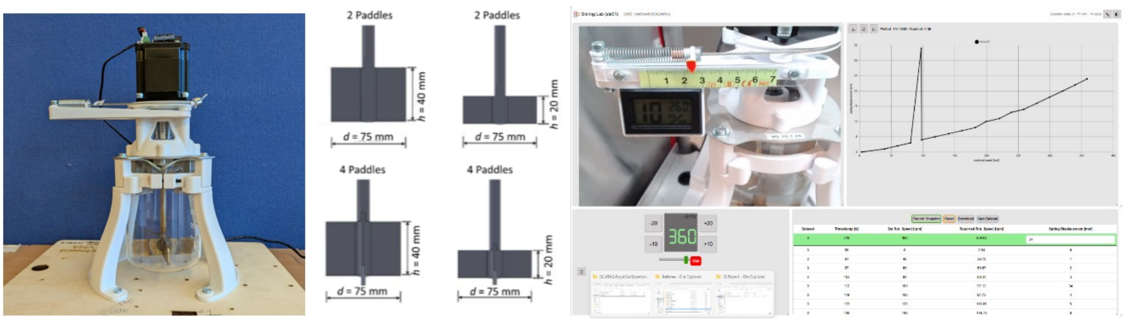

Figure 1. (left) Snapshot of the remote stirrer experimental apparatus including: the agitated vessel, the motor and angular speed control, and the spring connecting the fixed agitated vessel and the motor. (middle) Sketch of the different paddle configurations. (right) User Interface snapshot showing the live feed, control and data acquisition.

RESULTS

Participants will be able to gather data from the available remote stirrer configurations. Participants will also have access to the laboratory manual and to the experiment and assignment design [1]. The participants are then able to control the stirring speed and obtain the spring displacement in mm via the User Interface. Next, based on Hooke's law, the stirrer force, F (N), can be calculated by multiplying the spring constant, k (N/m) by its displacement, x (mm), as in Equation 2 and then plotted against stirring speed between 0 and 380 rpm as shown in Figure 2 (left).

$$F = k \cdot x \tag{1}$$

This is typically carried out for two different configurations. In the present case the same stirrer configuration under two fluids varying in viscosity. Further the relevant Power number Po and Reynolds number Re can be calculated making use of Equations 2 and 3.

$$Po = \frac{P}{\rho \omega^3 d^5} \tag{2}$$

$$Re = \frac{\rho \omega d^2}{\mu} \tag{3}$$

Dimensionalisation demonstrates how different configurations collapse within the same trend (Figure 2 (right)). The agreement evidences the importance of dimensionalisation in design and scaling up stirrer power and performance. In addition, a Jupyter Notebook exercise implemented in Notable allows students to plot and represent data, which will also be available for participants to try. The is also introduces students to basic coding scripts in preparation for a future course in Python.

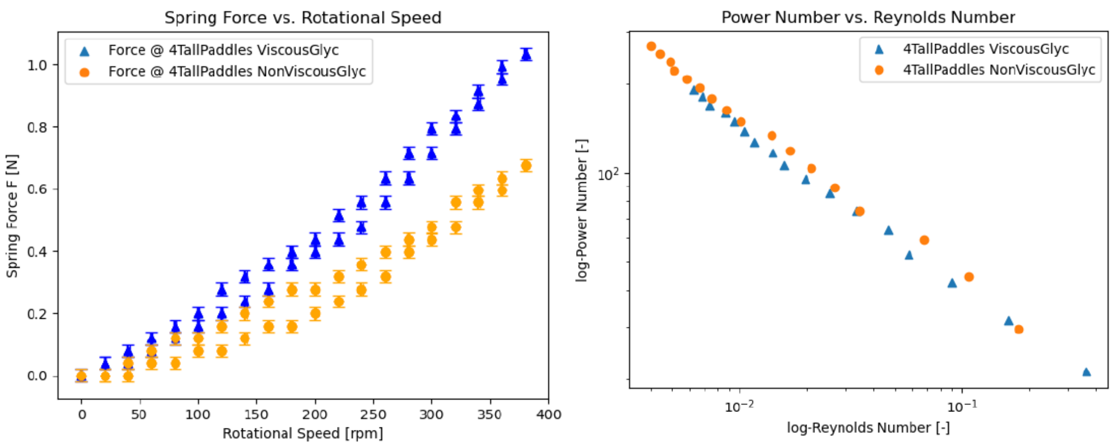

Figure 2. (Left) Stirring force or spring force, F (N), function of rotational speed (rpm) for the same paddles' configuration in (blue triangles) viscous glycerol and (orange circles) non-viscous vegetable glycerol. (left) Dimensionless Power number, Po, versus Reynolds number, Re, represented in a log-log scale for (blue triangles) viscous glycerol and (orange circles) non-viscous vegetable glycerol.

CONCLUSIONS

The designed remote laboratory provides a modern approach to laboratory experimentation and analysis as well as setting a foundation for a future Programming Skills course in Python.

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PEE044: LiaScript for real and virtual hardware control

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KEYWORDS

LiaScript, CAN, WebSerial, Remote delivery, Open day

ABSTRACT

Teaching staff within Warwick Manufacturing Group (WMG) have been using LiaScript to create and maintain course materials for multiple courses and modules due to it's easily collaborative development, version control and customisation capabilities which directly addressed several issues previously experiences with commercial e-learning creation software. The ability to embed interactive content directly alongside instructional materials has been a key feature that has been well received. This paper discusses how the highly extensible nature of LiaScript through its support for embedded HTML and JavaScript has allowed us to create interactive educational materials that directly control hardware devices from within teaching materials. The flexible nature and existing functionality has also allowed for easy repurposing of such materials for use in virtual open days for potential students; wherein multiple geographically distributed students were able to complete collaborative activities on a shared virtual CAN bus.

INTRODUCTION

The Intelligent Vehicles (IV) teaching group within WMG has been responsible for delivering Continuing Professional Development (CPD) courses to multiple commercial and government organisations. The group relied on a commercial software suite for materials development.

Following initial development, it became increasingly apparent that lack of collaborative development and version control functionality was causing significant difficulties regarding materials maintenance. Following an incident in which a significant amount of development work was lost, it became clear there was significant potential for course delivery if similar incidents were to occur in future.

As such members, the teaching group began to explore alternative software provisions. The loss of materials exemplified exactly the type of problem that robust version control is designed to eliminate, and so identifying an alternative platform which included or could support such functionality was a priority. As version control systems function best with text based files, and as the group had prior experience with markdown based document generation, this led very quickly to the identification of LiaScript as an alternative.

LIASCRIPT

LiaScript [1] is an open-source framework for creating interactive and multimedia-rich educational content using markdown. Although lacking some of the GUI development tools offered by the commercial suite, it offered dramatic improvements in collaborative development, version control and customisation. Indeed, as it supports embedding HTML and JavaScript, the extensibility of the platform is substantial.

EXTENSIONS

As stated previously, LiaScript offers significant extensibility through its support for embedded HTML and JavaScript, and this has been a key factor in its adoption by WMG teaching staff. This extensibility can be packaged into easily reusable macros that can be shared across courses and modules, allowing for the creation of a consistent and engaging learning experience for students [2]. Alongside use of community supplied macros, WMG teaching staff developed their own extensions for control hardware directly from within LiaScript teaching materials. Rather than having the instruction documents as a separate document and requiring students to switch between the instructions and external software, LiaScript allowed to the activities and instructions to be combined into a single source, with the instructions appearing alongside the interactive content.

This supported the development of a practical activity wherein students would work in groups to identify and exploit vulnerabilities in a simulated vehicle system via a simple CAN bus hack. Sniffing and sending CAN frames directly from LiaScript.

REMOTE-COLLABORATIVE ACTIVITIES

In 2025 WMG also ran virtual taster sessions for WMG offer holders. Rather than simply hosting a virtual lecture as is common, the teaching team proposed an interactive session that would give them a taste of the course materials and content. At first appearances the CAN hacking activity described in the previous section would appear a poor candidate, as it relies on specialised hardware not accessible to remote students. However, LiaScript's classroom functionality offered a solution. The included publish/subscribe functionality allows information to be transferred between LiaScript instances on different devices. The team was able to take the existing activity and with minor modifications, route CAN packets via LiaScript classroom instead of physical hardware.

The same information was being communicated and the information being intercepted and injected by students was the same. But instead of using a real physical CAN bus, the activity used a virtual CAN bus with virtual CAN nodes being geographically distributed wherever the open day attendees were.

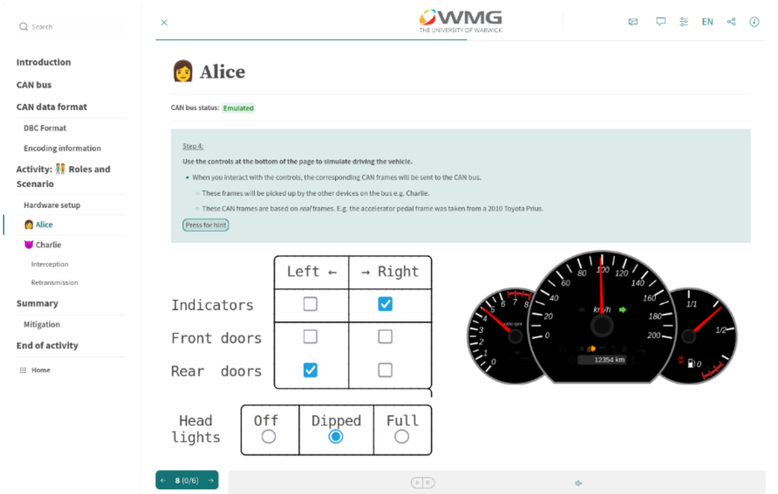

Figure 1. LiaScript page for virtual open day activity

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PEE047: Development and pre-evaluation of a batch reactor process laboratory via remote access to develop accompanying laboratory skills using the ADDIE model.

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KEYWORDS

Experimental learning, online prep, hands-on confidence, interactive learning environment

ABSTRACT

Remote unit operations or pilot-scale laboratories are a potentially useful component of any educator's tools box, especially after the COVID-19 pandemic's disruptive impact on the in-person learning process. Remote engineering teaching laboratories offer a robust and potentially contextualized solution for enhancing student engagement, accessibility, learning outcomes, and the learning environment, and to allow students to conduct experiments and engage with engineering processes from a realistic "distance" and "setting" **[1].**

This research aims to describe the process of developing a batch reactor remote laboratory process for Chemical and Environmental Process Engineering students using the ADDIE (Analyse, Design, Develop, Implement, Evaluate) model (Figure 1) [2]**.**

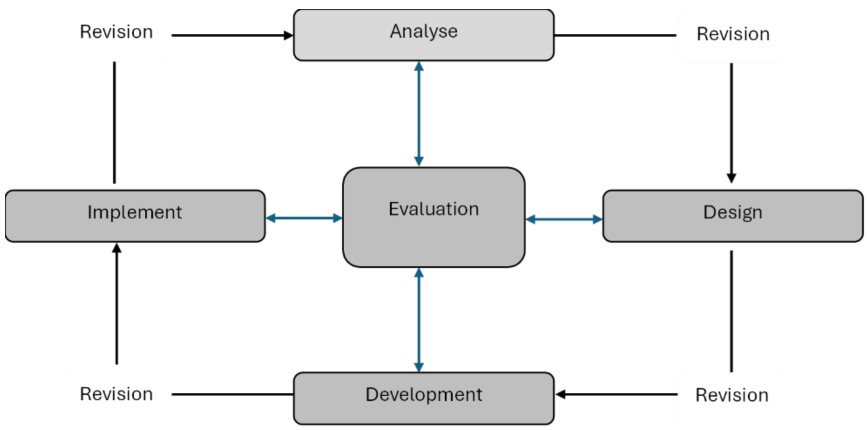

Figure 1: ADDIE (Analyse, Design, Develop, Implement, Evaluate) model.

INTRODUCTION

Between September 2019 and May 2020, I developed and pre-evaluated a UO27 batch reactor remote laboratory. The ADDIE (Analyse, Design, Develop, Implement, Evaluate) model was used in the development of the remote laboratory elements of a previously traditionally delivered practical. The ADDIE model is a proven method for the creation of resources and practices to aid understanding in learning [2].

The ADDIE model, it should be noted, is not a linear process. It does involve multiple interlinked and iterative elements that can create a degree of confusion when sectionalising the work performed. Consequently, a series of 'subsections' have been created to outline small elements within each of the ADDIE stages. Once these have been completed, the next stage of the ADDIE model is applied. Figure 2 shows the ADDIE model with the subsections displayed for the development of the remote laboratory, with indicators of the iterative substages.

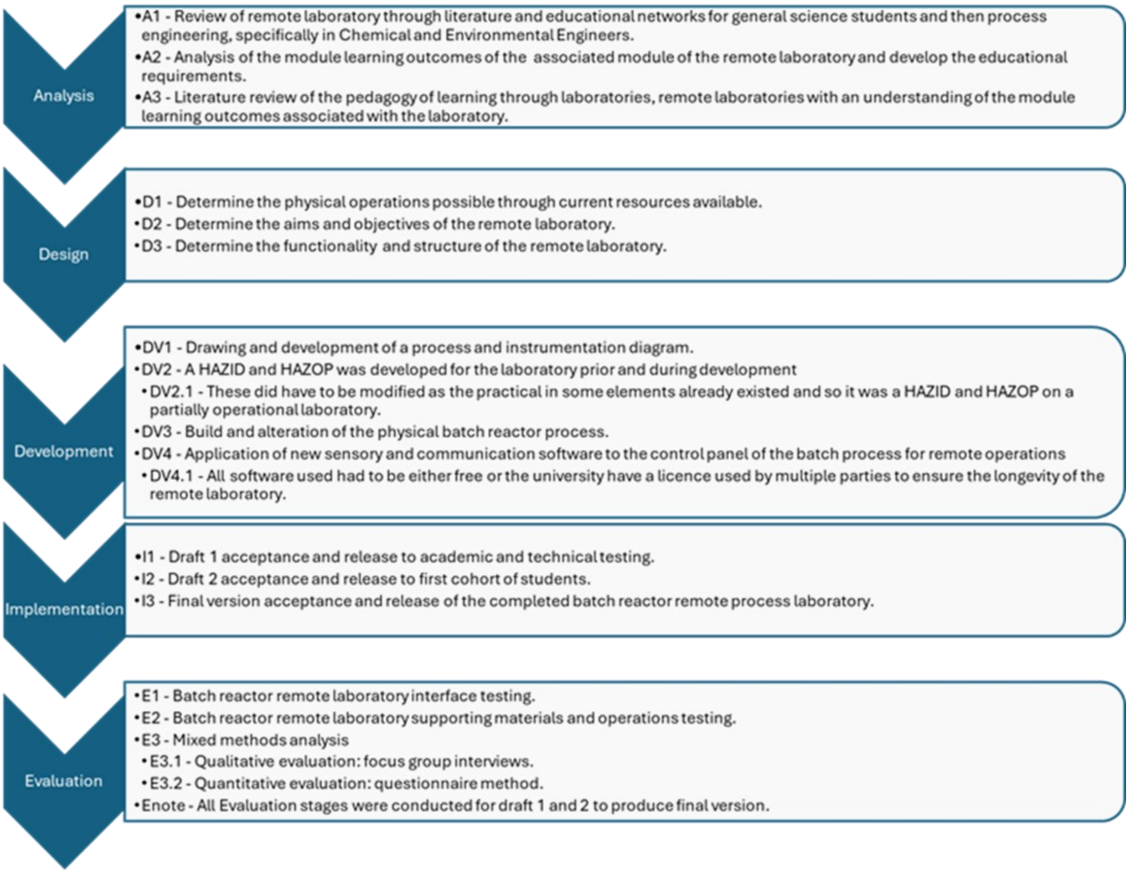

Figure 2: Project stages of the batch reactor according to the ADDIE model.

RESULTS

Using the ADDIE model creates results for each phase of the ADDIE operation.

Analysis: The literature exploration and subsequent 'Needs Analysis' yielded a series of articles for review and then generated a subsequent operational guide for the development of a remote laboratory with aims and objectives directed to meet/align with module learning outcomes (LO).

Design: Laboratories face restrictions due to the facility and resources to provide them. The design phase generated a current inventory of the facilities available for use and adaptation, a disused batch reactor. Based on the requirements from the analysis phase, specific aims and objectives were generated and then aligned with module requirements.

Development: The batch reactor process was built through a procedure mimicking industrial construction i.e., P&ID development, HAZID and HAZOP, build and alteration, and sensory deployment. The batch reactor itself became functional and was 'trailed' prior to being deemed operational.

In-situ to the physical build, a procedure for operation was developed that outlined the theory of the batch reactor, created links between lectures and the practical, and allowed students to 'experience' learning [3].

Implementation: From the academic year 2019 onwards, the remote batch reactor laboratory has been operating under an evolving improvement project.

Evaluation: The reactor is a physical process; repeatable and reproducible mass and energy balance data have been obtained from its operation. To evaluate the pedagogical impact, pre-tests and post-tests of understanding were administered. The mean test scores increased from the pre-test to the post-test, 57.67 ± 2.53, and it increased to 83.67 ± 5.58 in the post-test (Figure 3a). Using a perception questionnaire, feedback was collected on the ease of use, usefulness of the remote laboratory and student experience (Figure 3b).

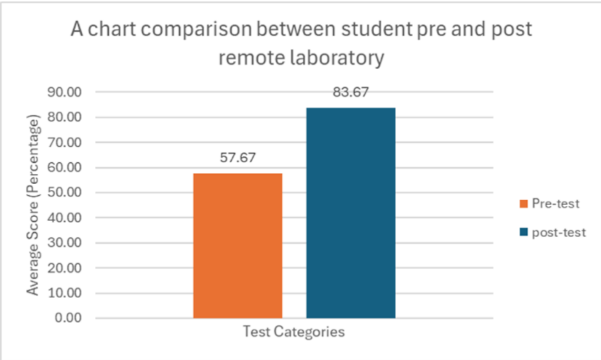

Figure 3: (a) and (b) showing student attainment pre- and post-laboratory, and student perception data for user understanding and operation.

CONCLUSIONS

We have successfully shown that a remote laboratory can influence a student's understanding to create an improved understanding of a process, either as a traditional laboratory did or not to any detriment. We have demonstrated that students' perceptions of their experiences are overwhelmingly positive but, again, not negatively affected by being a remote laboratory.

The next step involves the interpretation of the free text associated with the questionnaire and thematic analysis of the interview notes to obtain a more precise understanding of students' thoughts.

Additionally, another iterative ADDIE development-to-evaluation process will occur over the academic year 2025-26.

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PEE048: Digital First Labsheets

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KEYWORDS

Digital Labsheets, Accessibility, Inclusivity, Content Management

ABSTRACT

A labsheet is the typical method engineering educators use to provide students with the information needed to complete practical activities. These are often created in software designed around the printed page, such as MS Word or PDF, an approach not optimized for the digital displays through which students primarily consume information. At the University of Sheffield, we are standardizing our engineering labsheets using a digital first approach. Content is authored as plaintext using a bespoke markdown-based syntax, then rendered as web-based output optimized for a range of devices. Separating content from formatting ensures consistent presentation and efficiently maintains inclusivity standards across all disciplines.

INTRODUCTION

A labsheet is the typical method engineering educators use to provide students with all the information they need to complete their practical activities. Very often, these are created in software primarily designed to organize content around the printed page, such as MS Word or PDF. In practice, most students never print their materials; they access them on a screen. Providing students with teaching material built around a print layout has several disadvantages:

- They can render poorly on different screen sizes and orientation.
- They miss opportunities to leverage the advantages of digital technology.
- Their print-centric layouts make it harder to meet accessibility and inclusivity standards.
- Authors must manage styling and formatting within each document, distracting from the more important task of creating good content.
- Any change to style or formatting must be applied to each document individually, making updates time-consuming and inconsistent.

At the University of Sheffield, we are standardizing our engineering labsheets using a digital first approach. Content is authored as a plaintext file using a bespoke syntax based on markdown, which is then rendered as a web-based output optimized for a range of digital devices. Separating content from formatting ensures consistency in how information is presented and efficiently maintains inclusivity standards. The syntax and renderer are universally applicable to any laboratory activity, irrespective of discipline, and the full specification, alongside the renderer itself, is openly available for other educators to adopt, adapt, and extend within their own teaching.

The principle behind the approach is to separate the material content from the formatting, layout and presentation. This allows educators to easily build teaching material content and use this as an input into a separate process that renders the material as an output onto a student's device. The process of rending the content is systematically managed, to ensure it is user friendly on multiple devices, maintains inclusivity standards and corporate branding guidelines, and that if changes need to be made about how content is presented this can be implemented once and automatically implemented across all documents.

In addition to the ability to render teaching material for screens, using a digital first approach allows the creation of dynamic content. Interactive elements such as checkboxes, buttons or contents that reveal one certain condition can be used to create more customizable teaching material. For example, hyperlinks to different parts of the content can provide students with agency over the order or depth they engage with the material or multiple-choice quizzes can be embedded at key stages to assess understanding of key concepts.

IMPLENTATION

The cornerstone of this implementation of digital first teaching material is the definition of a plaintext format. This format is based on markdown. The justification is to ensure the text file is easily human readable and conforms to well established conventions. Standard markdown formatting, such as the definition of headings, subheadings, ordered and enumerated lists, are used. In addition, bespoke nomenclature has been created to identify within the material semantic meaning and manage the creation of interactive elements. A full definition of the syntax used is available at https://mee-labsheets.shef.ac.uk/docs

Content management system

In addition to the definition of the plaintext this implementation also includes:

1. A WYSIQYG editor to build and change the plaintext files in a user-friendly way.
2. A database for accessing, organizing and storing the plaintext files created by a team of teachers.
3. A "player" to render the plaintext file into a student facing output

Each of these aspects are modular and could operate independently. For example, the same plaintext file could be used as an input to multiple renders to generate differently formatted outputs. For this implementation, the markdown renders an output in html format to be read by a web browser. This has been chosen because of the ubiquity of web browsers on digital devices.

Application to labsheets

This approach suits the structured nature of laboratory teaching, where students undertake defined activities involving conceptual material and set tasks, and often take multiple lab classes designed by different staff. Health and safety briefings can be flagged with semantically meaningful callouts, ensuring critical information appears consistently across all labs. A stepped view serves discrete chunks of information one at a time, breaking complex procedures into manageable tasks, with embedded checks gating progress. Revealed content makes explanations, hints, or answers available on demand, supporting students who need more detail without cluttering the experience for others. These features map onto common laboratory pedagogy: signalling critical information, sequencing activity, and providing differentiated support.

Examples of functionally

- A "stepped" view can be presented to students by the renderer to serve discrete chunks of information one at a time. Assessment can be embedded to ensure conditions have been met before allowing progress to subsequent steps, A simple example would be asking students to check a box to declare they have achieved a task.
- Constantly styled inline text and call out boxes are used to identify semantically similar content, such as the definition of new terms or a hint.
- Collapsible content can "reveal" to provide additional information to students who require it. This can be used to efficiently answer anticipated questions.

PEE049: Citizen Science and Energy Literacy as Authentic Assessment in First-year Renewable Energy Engineering Students

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KEYWORDS

Citizen science; energy literacy; renewable energy engineering education.

ABSTRACT

Engineering education for renewable energy transitions must prepare students to work with technical uncertainty, social relevance and situated evidence from the beginning of their formation. This is particularly important in sustainable energy engineering, where curricula increasingly need to integrate renewable energy technologies, energy management, sustainability, ethics, and the conditions of underserved communities [1]. In this context, the project *Ciencia ciudadana para una ingenieria en energias renovables sustentable e incluyente* proposes a citizen science and energy literacy [2] platform for first-year students in the course Renewable Energies and Society, taught across the Temixco and Juriquilla campuses. Its first six months focused on designing the pedagogical and assessment architecture that allows practical work to become a formative, authentic and inclusive learning experience.

The project is grounded in evidence that citizen science can provide university students with authentic research experiences. Mitchell et al. showed that first-year students who collected and analysed citizen science data became more aware of data quality, reliability and error, especially when they moved from collecting observations to interpreting evidence and peer-reviewing scientific writing [3]. At the same time, the literature on postsecondary citizen science warns that, although these experiences are promising for engagement and authentic research, stronger empirical assessment of learning outcomes is still needed [4]. This creates a clear opportunity for the project: to treat citizen science not only as outreach or data collection, but as a structured assessment environment where students learn how to judge the quality and relevance of their own work. During the first six months, the project established a diagnostic baseline of students' knowledge, skills and perceptions; reviewed the curricular principles of Renewable Energies and Society; designed initial citizen science practices; and built shared protocols for observation, data collection, interpretation and communication. Tasks included documenting domestic energy use, identifying solar potential in public spaces, observing mobility patterns, and analysing everyday practices related to energy efficiency. These activities are aligned with prior work in engineering education showing that citizen science can help students observe real-life problems, identify design and sustainability implications, and connect engineering concepts with social and environmental contexts [5].

The contribution lies in treating assessment as a learning practice that develops students' capacity for future professional judgement, rather than as a final measurement of performance. In this design, students will not be assessed only on content recall or task completion. They will be asked to make and justify situated engineering judgements by connecting theory with observation, producing usable evidence, recognising uncertainty in data, communicating findings to non-specialist audiences, and revising their work through feedback. This approach is aligned with assessment for longer-term learning, where students gradually become capable of judging the quality of their own work in contexts like those they will encounter beyond the classroom [6]. It also connects with the notion of evaluative judgement: the ability to make informed decisions about the quality of one's own work

and that of others [7]. Feedback literacy is therefore central to the project, because students must learn to interpret comments, compare their work against explicit criteria, identify weaknesses in evidence and reasoning, and transfer feedback to subsequent practical tasks [8]. The project also recognises that course-based citizen science differs from voluntary participation. Students may initially be moved by grades rather than intrinsic interest, so the first phase will emphasise relevance, autonomy, structure and community value. Course-based undergraduate research experiences show that citizen science can strengthen awareness, community connection and communication skills for future professional practice [9]. In energy education, universities can also act as hubs for inclusive energy transition learning, connecting students, academics and communities through shared energy practices [10]. To sustain this, the platform will incorporate standardised protocols, teacher guidance and validation procedures, responding to concerns about data quality, participation and institutional support in higher education citizen science [11].

Overall, the project offers a transferable model for authentic assessment in first-year renewable energy engineering. By embedding feedback into citizen science and energy literacy practices, it seeks to form students who can learn from evidence, communicate responsibly, and design energy solutions with sustainability, inclusion and justice in mind.

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