THE UNIVERSITY of EDINBURGH School of Engineering

University of Sheffield | Centre for Engineering Education

Sustainability Awards 2024/25 Awarded Gold - Labs

Practical Engineering Education Conference

PEE2026

Practical Engineering Education

The Practical Engineering Education Conference 2026

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

THE UNIVERSITY of EDINBURGH

Sustainability Awards 2024/25 Awarded Gold - Labs

Practical Engineering Education

University of Sheffield | Centre for Engineering Education

TECQUIPMENT · GUNT TECHNOLOGY LIMITED · SMC · Didactic Services Ltd · MECHATRONICS · Ossila enabling science · ENGINEERING FOR CHANGE · QUANSER INNOVATE·EDUCATE · armfield A Judges Scientific company · Feedback LEYBOLD · THE UNIVERSITY of EDINBURGH School of Engineering · practable.io

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

Table of Contents

SPONSORS AND EXHIBITORS OF PEE26

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 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 COMMITTEES

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

SPONSORS

TECQUIPMENT	**TecQuipment** https://www.tecquipment.com/ Giving students at universities, colleges, schools, and training centres real-world understanding of the skills required in the engineering labour market through our practical lab equipment. Bridging theory and practice, it enables learners to apply engineering principles in hands-on environments.
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.
DSL Didactic Services Ltd	**DSL Didactic Services Ltd.** https://didacticservices.co.uk We bridge the gap between Education and Industry by being your go-to solution provider of World-class Learning Systems, Training & Support in high quality of Pneumatic, Hydraulic, Robotic, Industry 4.0, and/or Renewable Energy teaching equipment as well as training and staff development services. Our values range from Inspiring Learners to Long-term Partnerships, Empowerment and Personal Touch with focus on reshaping the future of Education in Engineering and Technology.

SMC

https://www.smc.eu/en-gb

Experts on solving industry challenges and your thorough contribution and support to automation trends, this latter related very much on how teaching and research laboratories are evolving. We meet your challenges in powertrain machining and assembly for automation technology, provide customized solutions to a wide-range of standard components and high-tech solutions, and deal with products for robotics.

Quanser

https://www.quanser.com/

Transforming educational experiences and accelerating innovate research. Quanser is a world leader in the design and development of cutting-edge solutions that form an interdisciplinary ecosystem for engineering education and research. Enabling innovative pedagogy, facilitating modern learning outcomes, bridging theory to live, accelerating innovative research and maximising the value of academic investment.

Armfield

https://armfield.co.uk/

Inspiring the next generation of engineers through the development of innovative teaching equipment. Since our inception in 1963 Armfield has been a proud, independent and responsible provider of technical equipment. Our equipment allows users to educate, test and research in innovative ways that fit their individual needs, while at the same time providing cost-effective, reliable and user-friendly products.
With our focus on delivering meaningful innovation and content, we serve multiple markets throughout the world in the areas of High Schools, Universities and Industrial Processing. We are a leader in Fluid Dynamics, Chemical, Civil, Mechanical Engineering, Food and Pharmaceutical Processing.

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.

AUTODESK	**Autodesk** https://www.autodesk.com/ https://www.autodesk.com/autodesk-university/ Autodesk's "Vision" centers on preparing the next generation of professionals for the AI-driven future of design, construction, and manufacturing. To achieve this, Autodesk partners with leading universities to embed industry-grade "Design and Make" software into standard curricula and establish specialized technology hubs.
THE UNIVERSITY *of* EDINBURGH School of Engineering	**School of Engineering Uni Edin** https://eng.ed.ac.uk/about/overview We are a world-leading engineering school, building on Edinburgh's legacy of innovation to advance global solutions through transformative research, education, and civic engagement. We educate and empower the next generation of engineering leaders, equipping them with the knowledge, creativity, and ethical responsibility needed to address the world's most urgent challenges. We build on the University's pioneering spirit since 1583. At the forefront of engineering innovation, we create solutions with real-world impact. From advancing data science and digital communications, to designing resilient infrastructure, to driving breakthroughs in biomedical engineering and energy sustainability, our research tackles today's toughest challenges with purpose and ingenuity.
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

PEE26 PRGORAMME - DAY 1

TIME	EVENT	LOCATION	EVENT	LOCATION
8:30-9:30	Registration, Breakfast/Coffee, Networking Sessions, Sponsors' Interactions			Nucleus Ground Floor
9:30-9:45	House Keeping and Opening Address: Professor Guangzhao Mao Head of School of Engineering, University of Edinburgh			Larch lecture theatre
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?			Larch lecture theatre
10:15-10:30	Sponsors Talk 1			
10:30-10:45	Sponsors Talk 2			
10:45-11:15	Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
TIME	EVENT	LOCATION	EVENT	LOCATION
11:15-12:30	Parallel Session 1 - Eng Practical HE Curriculum Transformation (x5)	Larch lecture theatre	Parallel Session 2 - Students Teacher Interactions (x5)	Rowan studio
12:30-13:30	Lunch & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
13:30-13:55	Keynote Talk 2 Professor Raffaella Ocone The Role of IChemE and Accreditation Institutions in Practical Engineering Education			Larch lecture theatre
TIME	EVENT	LOCATION	EVENT	LOCATION
14:00-14:40	Workshop 1 (x1)	Larch lecture theatre	Workshop 2 (x1)	Rowan studio
TIME	EVENT			LOCATION
14:45-15:00	Sponsors Talk 3			Larch lecture theatre
15:00-15:15	Sponsors Talk 4			
15:15-15:45	Poster Presentations Pitches - 3 mins each - Problem, Solution, Impact (x10)			
15:30-16:15	Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
15:30-16:15	Demonstration Sessions (x4)			Alder Lecture Theatre
16:15-17:00	Debate/Discussion Panel (x1)			Larch lecture theatre
17:00-18:00	Lab Visits AND/OR Time Off			Around Campus
19:00-22:00	Gala Dinner			In City Centre TBC

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 Talk 5			
9:45-10:00	Sponsors Talk 6			
10:00-10:15	Sponsors Talk 7			
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	Workshop 3 (x1) + Classroom Demonstration 3 (x1)	Larch lecture theatre	Classroom Demonstration 4 (x3)	Rowan studio
15:45-16:00	Sponsors Talk 8			Larch lecture theatre
16:00-16:45	Demonstration Sessions & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
16:00-16:45	Demonstration Sessions (x4)			Alder Lecture Theatre
16:45-17:00	Concluding Remarks			Larch lecture theatre
17:00	Lab Visits AND/OR Departure			Around Campus

PROGRAMME DAY 1

PEE26 PRGORAMME - DAY 1				
TIME		EVENT		LOCATION
8:30-9:30	Registration, Breakfast/Coffee, Networking Sessions, Sponsors' Interactions			Nucleus Ground Floor
9:30-9:45	House Keeping and Opening Address: Professor Guangzhao Mao Head of School of Engineering, University of Edinburgh			Larch lecture theatre
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?			Larch lecture theatre
10:15-10:30	Sponsors Talk: TecQuipment			
10:30-10:45	Sponsors Talk: Gunt Technology			
10:45-11:15	Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
TIME	EVENT	LOCATION	EVENT	LOCATION
11:15-12:30	**Parallel Session 1 - Engineering Practice in HE and Curriculum Transformation** **Chair: TBC**	Larch lecture theatre	**Parallel Session 2 - Students Teacher Interactions** **Chair: TBC**	Rowan studio
11:15-11:30	14. Dreaming A New Undergraduate Engineering Curriculum Together		09. Co-Creating Inclusive Engineering Laboratories: Embedding Accessibility and Belonging	
11:30-11:45	7. A Multi-Stakeholder Approach to Practical Curriculum Transformation in Engineering Education		16. To Get The Cow Off The Ice: On Ultraconcurrent Remote Laboratories and Their Importance For Accessible STEM Laboratory Education	
11:45-12:00	38. A new 'backbone' for our Mechanical Engineering degree programmes		23. Reinforcing Practical Engineering Education Through an Early-Engagement Research Lab Model	
12:00-12:15	6. Embedding a Professional from Day One (PFD1) Culture into the School of Engineering and Built Environment		3. Enhancing Students' Engagement by Innovative Experimental Approach for Problem-Solving Questions in the Foundation Year Tutorial	
12:15-12:30	1. From Molecules to Meaning: A 10-Dimensional Framework for Post-2030 Chemical Engineering Education		50. Remote Lab Challenge: Co-Creating the Future of Laboratory Education through Challenge-Based Learning	
12:30-13:30	Lunch & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
13:30-13:55	Keynote Talk 2 Professor Raffaella Ocone			Larch lecture theatre

	The Role of IChemE and Accreditation Institutions in Practical Engineering Education			
TIME	EVENT	LOCATION	EVENT	LOCATION
14:00-14:40	**Workshop 1** **Chair: TBC**	Larch lecture theatre	**Workshop 2** **Chair: TBC**	Rowan studio
14:00-14:40	26. Experiments ReLOAD and enLITEened		27. Induction as the First Engineering Project: Practical Approaches to Building Confidence and Belonging	
TIME		EVENT		LOCATION
14:45-15:00	**Sponsors Talk: Feedback**			Larch lecture theatre
15:00-15:15	**Sponsors Talk: Didactic Services DSL**			
15:15-15:30	**Poster Presentations Pitches - 3 mins each - Problem, Solution, Impact** **Chair: TBC**			
15:15-15:30	28.Technology Demonstrator: A Modular Open-Lab Concept for Short, Self-Directed, Team-Based Engineering Practice in Higher Education			
15:15-15:30	34.Role of Undergraduate Student-Led Societies in Practical Engineering			
15:15-15:30	41. What Students Really Do In Jupyter Notebooks			
15:15-15:30	45.Project-Based Learning Through Undergraduate Research Internships			
15:15-15:30	49. Citizen Science and Energy Literacy as Authentic Assessment in First-year Renewable Energy Engineering Students			
15:15-15:30	46. Development & pre-Evaluation of Batch Reactor Process Laboratory via Remote Access to Develop Accompanying Laboratory Skills using the ADDIE Model			
15:15-15:30	48. Digital First Labsheets			
15:15-15:30	10. Teacher-Student Interaction in a Hybrid Remote Laboratory Setting			
15:30-16:15	**Demonstration Sessions & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**			Alder Lecture Theatre
15:30-16:15	21.MIRTE: Choose Your Own (Robot) Adventure			Alder Lecture Theatre
15:30-16:15	31.Bringing digitalisation into the laboratory: a Single Tube Condenser case study			
15:30-16:15	40. ACE-Lab: A Practical, Application-Led Framework for Control Engineering Education			
15:30-16:15	48. Digital First Labsheets			
15:30-16:15				
15:30-16:15				
16:15-17:00	**Debate/Discussion Pannel**			Larch lecture theatre
16:15-17:00	35. This house believes the future of practical engineering education is on digital twins coupled to virtual reality?			
TIME		EVENT		LOCATION
19:00-20:00	**Gala Dinner in City Centre for ALL**			Venue TBC

PROGRAMME DAY 2

PEE26 PRGORAMME - DAY 2				
TIME		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 Talk: Quanser			
9:45-10:00	Sponsors Talk: Autodesk			
10:00-10:15	Sponsors Talk: Mechatronics			
10:15-10:45	Coffee Break, Networking Sessions, Sponsors' Interactions and Posters			Alder Lecture Theatre
TIME	EVENT	LOCATION	EVENT	LOCATION
10:45-12:15	Parallel Session 3 - Problem Project Scenario Based Learning Chair: TBC	Larch lecture theatre	Parallel Session 4 - Transformative Assessment & Digitalisation AI in PEE Chair: TBC	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		19. Beam Bending Rig Project: Bringing It All Together	
11:00-11:15	24. Co-Solving of Non-Hypothetical Problems to Facilitate Innovation		13. Verifying Engineering Competence Through Direct Observation: A Curriculum-Wide Transformation	
11:15-11:30	2. Hands-on Teaching and Learning in a Complex Safety Critical Environment		4. A Formative and Comprehensive Personalised Feedback Technique for Small Cohorts in Electrical Engineering Coursework	
11:30-11:45	8. Small Measures: Practical Tasks for Teaching Statistical Process Control		15. From Equations to Experiences: A Spreadsheet-based Approach to Teaching Finite Element Theory	
11:45-12:00	20. Designing for Density: Scaling Active, Student-Executed Laboratories in Large-Cohort Engineering Programmes		05. From AI Anxiety to Practical Mastery: Scaffolded Approach to AI Modeling in Civil Engineering Education—Building Energy Case Study	
12:00-12:15	11. Industrial contribution to Civil Engineering Programmes			

	at University College Dublin, Ireland			
12:15-13:15	**Lunch & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**			Alder Lecture Theatre
TIME	EVENT	LOCATION	EVENT	LOCATION
13:15-14:15	**Classroom Demonstration 1 Chair: TBC**	Larch lecture theatre	**Classroom Demonstration 2 Chair: TBC**	Rowan studio
13:15-13:45	36. Learn By Doing: An Interactive Lab on Culinary Fluid Mechanics		30. Every Third Week is a Project Week: Embedding Project-Based Learning in Early Engineering Education	
13:45-14:15	33.A Virtual Site Visit to Engage First Year Chemical Engineering Students		17. Leveraging Peer Feedback for Assessment Literacy: the Peerceptiv Project	
TIME	EVENT	LOCATION	EVENT	LOCATION
14:15-15:45	**Workshop 3 + Classroom Demonstration 3 Chair: TBC**	Larch lecture theatre	**Classroom Demonstration 4 Chair: TBC**	Rowan studio
14:15-14:45	43. Refrigeration Remote Lab and Calc App for Thermodynamics		29. Co-Designed Engineering Labs: A Practical-Based Learning Model Integrating Peer Feedback for Inclusive and Experiential Skill Development (40 minutes)	
14:45-15:15	~~25. Practical Vehicle Automation using CAN~~			
15:15-15:45	39. Supporting student-led, self-directed learning with a new structural dynamics remote laboratory		32.Rubric grades simplification and marking scheme-feedback unification for best practice in (Chemical) Engineering Laboratories (40 minutes)	
15:45-16:00	**Sponsors Talk: Practable.io, E4C & School of Engineering**			Alder Lecture Theatre
16:00-16:45	**Demonstration Sessions & Coffee Break, Networking Sessions, Sponsors' Interactions and Posters**			Alder Lecture Theatre
16:00-16:45	37. Bubble/Balloon Bursting for Exemplifying Fluid Dynamics to Pupils			Alder Lecture Theatre
16:00-16:45	22. Design and Implementation of a Low-Cost CAN-Based Adaptive Cruise Control			
16:00-16:45	46. From student project to teaching practice: A green hydrogen generation and utilisation activity for Electrochemical Engineering Education			
16:00-16:45	42. Stirrer Remote Labs in Chemical Engineering Design 1			
16:45-17:00	**Concluding Remarks**			Larch lecture theatre
17:00	**Lab Visits AND/OR Departure**			Around 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

M. G. Hassan-Sayed [1,*]

[1] Director of Programs, Associate Professor in Sustainable Engineering Systems, School of Chemistry and Chemical Engineering, building 27-30 University of Southampton, SO17 1BJ, UK

* Presenting author: mghs1v19@soton.ac.uk

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

Zena Green[1,*], Felix Schmid[1], Stephen Kent[1]

[1] Civil Engineering, School of Engineering, University of Birmingham, Birmingham B15 2TT, UK

* Presenting author: z.green.2@bham.ac.uk

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.

References

[1] Eva Vítková, Jana Korytárová, Vít Hromádka, Support Work Experience of Students in Civil Engineering,

Procedia - Social and Behavioral Sciences, 2013, Volume 93, Pages 1940-1944,

[2] Volunteer it yourself. VIY projects. https://volunteerityourself.org/projects/

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

Mrs. D. Goswami[1,*], Dr. P. Lutsyk1

[1] College of Engineering and Physical Science, Aston University, Birmingham, B47ET, UK

* Presenting author: d.goswami@aston.ac.uk

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.

References

[1] Kahu, E. R. Framing Student Engagement in Higher Education. Stud. High. Educ. 2013, 38 (5), 758–773. https://doi.org/10.1080/03075079.2011.598505.

[2] McCourt, A.; Carr, C. Improving Student Engagement and Retention through Small Group Tutorials. Innov. Teach. Learn. Inf. Comput. Sci. 2010, 9 (1), 61–77. https://doi.org/10.11120/ital.2010.09010061.

[3] Freeman, S.; Eddy, S. L.; McDonough, M.; Smith, M. K.; Okoroafor, N.; Jordt, H.; Wenderoth, M. P. Active Learning Increases Student Performance in Science, Engineering, and Mathematics. Proc. Natl. Acad. Sci. U.S.A. 2014, 111, 8410–8415.

[4] Prince, M. Does Active Learning Work? A Review of the Research. J. Eng. Educ. 2004, 93, 223–231.

[5] Hake, R. R. Interactive-Engagement versus Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data. Am. J. Phys. 1998, 66, 64–74.

[6] Nolan, B.; Ní Fhloinn, E. Notes on Group-Work Based Tutorials in a Large Service Teaching Module. Proc. Fifth Natl. Conf. Res. Math. Educ. (MEI 5) 2013, 248–259.

[7] Michael, J. Where's the Evidence that Active Learning Works? Adv. Physiol. Educ. 2006, 30, 159–167.

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

I. A. Rudden[1], M. I. Masoud[2,*]

[1] DNV, London Area, UK

[2] EEE School, University of Sheffield, S13JD, UK

* Presenting author: m.masoud@sheffield.ac.uk

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.

References

[1] Morris, R., Perry, T. and Wardle, L., 2021. Formative assessment and feedback for learning in higher education: A systematic review. Review of Education, 9(3), p.e3292.

[2] Wiliam, D., 2018. Feedback: At the heart of—but definitely not all of—formative assessment.

[3] Gaynor, J.W., 2020. Peer review in the classroom: Student perceptions, peer feedback quality and the role of assessment. Assessment & Evaluation in Higher Education, 45(5), pp.758-775.

[4] Jonsson, A., 2013. Facilitating productive use of feedback in higher education. Active learning in higher education, 14(1), pp.63-76.

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

Mohamed I. Abd[1,2,*], Farah Adem[2]

[1] Department of Civil and Construction Engineering, School of Engineering, National Taiwan University of Science and Technology, 106335, Taiwan

[2] Department of Civil Engineering, School of Engineering, Gollis University, Hargeisa, Somaliland

* Presenting author: D11305810@mail.ntust.edu.tw

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.

[1] M. Jacobs, D. Kane, R. Yahne, and W. Goodridge, "Challenges and Opportunities: A Systematic Review of AI Tools in Engineering Education," in 2025 ASEE Annual Conference & Exposition Proceedings, ASEE Conferences, 2025. https://doi.org/10.18260/1-2--56075.

[2] S. K. Banihashem, M. Bond, N. Bergdahl, H. Khosravi, and O. Noroozi, "A systematic mapping review at the intersection of artificial intelligence and self-regulated learning," Int. J. Educ. Technol. High. Educ., vol. 22, no. 1, p. 50, Aug. 2025. https://doi.org/10.1186/s41239-025-00548-8.

[3] C. H. Su, "The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study," Multimed. Tools Appl., vol. 75, no. 16, pp. 10013–10036, 2016. https://doi.org/10.1007/s11042-015-2799-7.

[4] J. Schleiss and A. Johri, "a Roles-Based Competency Framework for Integrating Artificial Intelligence (Ai) in Engineering Courses," SEFI 2024 - 52nd Annu. Conf. Eur. Soc. Eng. Proc. Educ. Responsible Eng., pp. 2116–2125, 2024. https://doi.org/10.5281/zenodo.14256779.

[5] M. E. Auer, U. R. Cukierman, E. V. Vidal, E. Tovar, and C. Editors, Towards a Hybrid, Flexible and Socially Engaged Higher Education, vol. 899. in Lecture Notes in Networks and Systems, vol. 899. Cham: Springer Nature Switzerland, 2024. https://doi.org/10.1007/978-3-031-51979-6.

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

Victoria L. Mellon[1], Alan F. Holloway [1]

[1] School of Engineering & Built Environment, Sheffield Hallam University, Sheffield, S1 1WB, UK

* Presenting author: v.mellon@shu.ac.uk

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.

References

Bennedsen, J.; Rouvrais, S.; Roslöf, J.; Kontio, J.; Georgsson, F.; McCartan, C. Collaborative Quality Enhancement in Engineering Education: An Overview of Operational Models at a Programme Level. European Journal of Engineering Education 2020, 45 (1), 73–88.

Hinkle, C.; Koretsky, M. Toward Professional Practice: Student Learning Opportunities Through Participation in Engineering Clubs. European Journal of Engineering Education 2019, 44, 906–922. https://doi.org/10.1080/03043797.2018.1477119.

Jamison, C.; Lattuca, L.; Daly, S.; Huang-Saad, A. Biomedical Engineering Students' Perceived Learning Through Co-Curriculars. Studies in Engineering Education 2023. https://doi.org/10.21061/see.94.

Murray, M.; Pytharouli, S.; Douglas, J. Opportunities for the Development of Professional Skills for Undergraduate Civil and Environmental Engineers. European Journal of Engineering Education 2022, 47, 793–813. https://doi.org/10.1080/03043797.2022.2031897.

O'Rielly, L.; Genge, B.; Nguyen, T.; Snow, S.; Osgood, L. Engineering Careers and Career Engineering: An Evaluation of Undergraduate Professionalism Programming. Proceedings of the Canadian Engineering Education Association (CEEA) 2025. https://doi.org/10.24908/pceea.2025.19683.

Olewnik, A.; Chang, Y.; Su, M. Co-Curricular Engagement among Engineering Undergrads: Do They Have the Time and Motivation? Int. J. STEM Educ. 2023, 10. https://doi.org/10.1186/s40594-023-00410-1

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

Zareena Gani[1,*], Bhagyalakshmi Dasari[1], Marilize Everts[1], Andrea Grech La Rosa[1], Christian Klettner[1], Llewellyn Morse[1]

[1] Mechanical Engineering, University College London, London, WC1E 6BT, UK

[*] Presenting author: z.gani@ucl.ac.uk

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.

References

[1] Succi, C.; Canovi, M. Soft Skills to Enhance Graduate Employability: Comparing Students and Employers' Perceptions. Stud. Higher Educ. 2020, 45 (9), 1834–1847. https://doi.org/10.1080/03075079.2019.1585420

[2] Bovill, C. An Investigation of Co-Created Curricula within Higher Education in the UK, Ireland and the USA. Innovations Educ. Teaching Int. 2014, 51 (1), 15–25. https://doi.org/10.1080/14703297.2013.770264

[3] Healey, M.; Flint, A.; Harrington, K. Students as Partners: Reflections on a Conceptual Model. Teach. Learn. Inq. 2016, 4 (2), 8–20. https://doi.org/10.20343/teachlearninqu.4.2.3

[4] Wiek, A.; Withycombe, L.; Redman, C. L. Key Competencies in Sustainability: A Reference Framework for Academic Program Development. Sustainability Sci. 2011, 6 (2), 203–218. https://doi.org/10.1007/s11625-011-0132-6

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

John P. Shackleton[1,*]

[1] James Watt School of Engineering, University of Glasgow, G12 8QQ, Scotland, UK

* Presenting author: john.p.shackleton@glasgow.ac.uk

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

Munira Raja[1,*], Nouran Elbana[1], Hamza Taher[1], Mohammed Hassan[1], Pantxika Morlat[2] and Maria Limniou[2]

[1] Department of Electrical Engineering and Electronics, Faculty of Science and Engineering, University of Liverpool, Liverpool L69 3GJ, UK

[2] Department of Psychology, Faculty of Health and Life Science, University of Liverpool, Liverpool L69 7ZA, UK

* Presenting author: mraja@liverpool.ac.uk

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.

References

[1] Batty, L., & Reilly, K. *Understanding barriers to participation within undergraduate STEM laboratories: towards development of an inclusive curriculum*. Journal of Biological Education, 2023. 57(5), 1147–1169. https://doi.org/10.1080/00219266.2021.2012227.

[2] Singh, R., & Kittur, J. *Inclusive Teaching Practices in Engineering: A Systematic Review of Articles from 2018 to 2023,* ASEE Annual Conference & Exposition, 2024, Portland, Oregon.

[3] Cook-Sather, A., Bovill, C., & Felten, P. *Engaging students as partners in learning and teaching: A guide for faculty*. John Wiley & Son, 2014.

[4] Crawley, E.F., Malmqvist, J., Östlund, S., Brodeur, D.R., Edström, K. *The CDIO Approach: Rethinking Engineering Education*. Springer, Cham. 2014, https://doi.org/10.1007/978-3-319-05561-9_2

[5] Institution of Engineering and Technology. *Academic Accreditation.* The Institution of Engineering and Technology. Academic accreditation (accessed February 24, 2026).

[6] Institution of Engineering and Technology. *Equality, Diversity and Inclusion Action Plan.* The Institution of Engineering and Technology. Equality, Diversity and Inclusion action plan (accessed February 24, 2026)

[7] Advance HE. *Equality in Higher Education: Statistical Report 2024*; Advance HE: York, UK, 2025. Equality in higher education: statistical report 2024 | Advance HE (accessed February 24, 2026)

PEE10: Teacher-Student Interaction in a Hybrid Remote Laboratory Setting

Yiwen Xu[1,*]

[1] Institute for Imaging, Data and Communications, School of Engineering, The University of Edinburgh, University, EH, UK

* Presenting author: Y.Xu-215@sms.ed.ac.uk

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

Abstract

Engineering laboratory teaching usually emphasises learning content; however, studies show that learning is also shaped by teacher-student interactions including instructional guidance[1], active student participation[2] and students' sense of belonging[3]. With the adoption of remote laboratories in undergraduate learning[4][5], teacher-student interaction is mediated by interfaces and networked devices, reshaping interactional conditions. Evidence suggests that online learning may weaken immediacy[6]and alter communication patterns[7], but empirical evidence remains limited regarding the student perceptions of teacher–student interaction in blended laboratory settings. In this paper, blended remote laboratory settings refer to co-located workshops where students use remote-access equipment under teacher guidance, followed by independent at-home tasks. The study examines students' perceptions of teacher–student interaction in this context to identify functions and barriers, thereby informing theory acceptance and laboratory design.

The study involved undergraduate engineering students enrolled in a blended remote laboratory workshop. Students first operated remote laboratories in a scheduled classroom with guidance from multiple co-located teachers, and subsequently completed tasks independently at home. Data were collected through semi-structured interviews with six students and analysed using inductive thematic analysis, focusing on helpful and challenging interactions and changes across the workshop-to-home transition.

Three interaction functions were identified: building social connections in workshops, understanding through modelling and troubleshooting, and offering emotional support when failure or uncertainty occurs. Technological interference emerged as a recurrent barrier, increasing cognitive load as students had to translate system feedback into actionable information for teachers. The study offers an empirically grounded account of phase-specific shifts in the functions of teacher–student interaction in blended remote laboratory settings. The three functions identified in this study appear to align closely with the Community of Inquiry framework, indicating its potential as a theoretical foundation for future research.

References

[1] Wei, J.; Mocerino, M.; Treagust, D. F.; Lucey, A. D.; Zadnik, M. G.; Lindsay, E. D.; Carter, D. J. Developing an Understanding of Undergraduate Student Interactions in Chemistry Laboratories. Chem. Educ. Res. Pract. 2018, 19 (4), 1186–1198. https://doi.org/10.1039/C8RP00104A.

[2] Viegas, C.; Pavani, A.; Lima, N.; Marques, A.; Pozzo, I.; Dobboletta, E.; Atencia, V.; Barreto, D.; Calliari, F.; Fidalgo, A.; Lima, D.; Temporão, G.; Alves, G. Impact of a Remote Lab on Teaching Practices and Student Learning. Computers & Education 2018, 126, 201–216.

[3] Lyles, C.; McNair, L.; Reeping, D. Sense of Belonging in Large Online Engineering Classes: A Scoping Review. In 2021 ASEE Virtual Annual Conference Proceedings; ASEE Conferences: Virtual Conference, 2021; p 37708.

[4] Letowski, B.; Lavayssière, C.; Larroque, B.; Schröder, M.; Luthon, F. A Fully Open Source Remote Laboratory for Practical Learning. Electronics 2020, 9 (11), 1832.

[5] Fallon, T. Survey of Existing Remote Laboratories Used to Conduct Laboratory Exercises for Distance Learning Courses. In 2013 ASEE Annual Conference & Exposition Proceedings; ASEE Conferences: Atlanta, Georgia, 2013; p 23.1119.1-23.1119.12. https://doi.org/10.18260/1-2--22504.

[6] Szeto, E.; Cheng, A. Y. N. Towards a Framework of Interactions in a Blended Synchronous Learning Environment: What Effects Are There on Students' Social Presence Experience? Interact. Learn. Environ. 2016, 24 (3), 487–503.

[7] Brown, V.; Collins, T.; Braithwaite, N. St. J. Teaching Roles and Communication Strategies in Interactive Web Broadcasts for Practical Lab and Field Work at a Distance. Front. Educ. 2023, 8, 1198169.

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

Patrick J. Purcell[1,*]

[1] School of Civil Engineering, University College Dublin, Dublin, Ireland

* Presenting author: PJ.Purcell@ucd.ie

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.

References

[1] Engineers Ireland Accreditation Criteria, 2024, https://www.engineersireland.ie/listings/resource/198.

[2] Felder, R, 2009, Active Learning: An Introduction. https://engr.ncsu.edu/wp-content/uploads/drive/1XaOo9WCKcMq6-fTcQGidOT2SDGqg70l5/2009-ALpaper(ASQ).pdf

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

References

[1] Chu, Y.; Li, H.; Copur-Gencturk, Y.; Yang, K.; Tang, J. LLM-Based Automated Grading with Human-in-the-Loop. arXiv 2025, arXiv:2504.05239.

[2] Fajardo-Ramos, D. C.; Chiappe, A.; Mella-Norambuena, J. Human-in-the-Loop Assessment with AI: Implications for Teacher Education in Ibero-American Universities. Front. Educ. 2025, 10, 1710992.

[3] MacDonald Burke, C. AI-Assisted Exam Variant Generation: A Human-in-the-Loop Framework for Automatic Item Creation. Educ. Sci. 2025, 15, 1029.

[4] Armfield, D.; Chen, E.; Omonkulov, A.; Tang, X.; Lin, J.; Thiessen, E.; Koedinger, K. Avalon: A Human-in-the-Loop LLM Grading System with Instructor Calibration and Student Self-Assessment. Commun. Comput. Inf. Sci. 2025, 2592, 111–118.

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

Harm van Zalinge[1,*], Waleed Al-Nuaimy[1], Fatme Elhouni[1], Munira Raja[1]

[1] Department of Electrical Engineering and Electronics, School of Engineering, University of Liverpool, Liverpool, L69 3GJ, UK

* Presenting author: vzalinge@liverpool.ac.uk

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

Christopher J. M. Smith[1,*], Elaine Clafferty[1], Charlay Walker[1, 2], Geraint Bevan[1]

[1] Department of Engineering, School of Science & Engineering, Glasgow Caledonian University, Glasgow G4 0BA, Scotland, UK.

[2] GCU Students Association, Glasgow G4 0BA, Scotland, UK.

* Presenting author: Christopher.Smith@gcu.ac.uk

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).

References

[1] Student engagement. Qaa.ac.uk. https://www.qaa.ac.uk/scotland/tertiary-quality-enhancement-framework/student-engagement (accessed 2026-02-25).

[2] Matthews, K. E.; Dollinger, M. Student Voice in Higher Education: The Importance of Distinguishing Student Representation and Student Partnership. Higher Education 2022, 85, 555–570. https://doi.org/10.1007/s10734-022-00851-7.

[3] Omland, M.; Hontvedt, M.; Siddiq, F.; Amundrud, A.; Hermansen, H.; Mathisen, M. A. S.; Rudningen, G.; Reiersen, F. Co-Creation in Higher Education: A Conceptual Systematic Review. Higher Education 2025. https://doi.org/10.1007/s10734-024-01364-1.

[4] Nuutinen, L.; Heikkinen, H. L. T.; Tynjälä, P. Utilizing Appreciative Inquiry in Educational Development. Educational Action Research 2025, 1–27. https://doi.org/10.1080/09650792.2025.2577993.

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

Ben Edmans[1,*]

1 School of Engineering and Built Environment, Sheffield Hallam University, Sheffield S1 1WB, UK

* Presenting author: b.edmans@shu.ac.uk

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.

References

[1] Bowden, J. A. Capabilities-Driven Curriculum Design. In *Effective Learning and Teaching in Engineering*; Baillie, C., More, I., Eds.; RoutledgeFalmer: New York, 2004; pp. 36–47.

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

Marcel Schade[1,*], Thekla M. Borrmann[2], Tobias R. Ortelt[1], Carsten Bender[2], Claudius Terkowsky[3]

[1] Coordination of Digital Teaching, Centre for Higher Education, TU Dortmund University, Dortmund, 44227, Germany

[2] Dortmund Disability and Studies, Centre for Higher Education, TU Dortmund University, Dortmund, 44227, Germany

[3] Chair for Organisational Studies and Management of Continuing Education, Centre for Higher Education, TU Dortmund University, Dortmund, 44227, Germany

* Presenting author: marcel.schade@tu-dortmund.de

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.

References

[1] Ortelt, T.R., personal aphorism (since 2021).

[2] Steinkühler, J., Beuße, M., Kroher, M., Gerdes, F., Schwabe, U., Koopmann, J., ... & Buchholz, S.: Die Studierendenbefragung in Deutschland: best3: Studieren mit einer gesundheitlichen Beeinträchtigung, 2023, Berlin.

[3] "Ordinance on Accessible Information Technology" (German: Barrierefreie-Informationstechnik-Verordnung - BITV 2.0), 2023/10/24, https://www.gesetze-im-inter-net.de/bitv_2_0/BJNR184300011.html, last accessed 2025/11/11.

[4] DIRECTIVE (EU) 2016/2102 on the accessibility of the websites and mobile applications of public sector bodies 2016/10/26, https://eur-lex.europa.eu/legal-con-tent/DE/TXT/PDF/?uri=CELEX:32016L2102, last accessed 2025/11/11.

[5] W3C, Web Content Accessibility Guidelines (WCAG) 2.2: W3C Recommendation 12 December 2024, https://www.w3.org/TR/WCAG22/, last accessed 2026/26/02.

[6] May, D., Terkowsky, C., Varney, V., & Boehringer, D., Between hands-on experiments and Cross Reality learning environments–contemporary educational approaches in instructional laboratories. *EJEE*, 2023, *48*(5), 783-801.

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

Elena Ioannidou[1,*], Dave Laurenson[1], Joy Lan[2]

[1] School of Engineering, University of Edinburgh, Edinburgh EH8 9YL, United Kingdom

[2] Moray House School of Education and Sport, University of Edinburgh, Edinburgh EH8 9YL, United Kingdom

* Presenting author: eioannid@ed.ac.uk

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.

References

[1] Topping, K. J. Peer Assessment. *Theory Into Practice*, (2009), 48(1), 20–27. https://doi.org/10.1080/00405840802577569

[2] Cummings, J., Marshall, J., Murphy, B., Robertson, E., & Williams, M. *Students as Assessors: Peer assessment and the benefits to students and staff,* (2024) University of Strathclyde. https://www.strath.ac.uk/media/ps/humanresources/cse/step/Students_as_Assessors_Peer_assessment_and_the_benefits_to_students_and_staff.pdf

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

Marilize Everts[1,2,*], Llewellyn Morse[1], Zareena Gani[1]

[1] Department of Mechanical Engineering, Faculty of Engineering Science, University College London, London WC1E 6BT, UK, United Kingdom

[2] Department of Mechanical and Aeronautical Engineering, School of Engineering, University of Pretoria, Pretoria, 0008, South Africa

* Presenting author: m.everts@ucl.ac.uk

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.

References

[1] Succi, C.; Canovi, M. Soft skills to enhance graduate employability: comparing students and employers' perceptions. Studies in Higher Education 2020, 45 (9), 1834-1847.

[2] Abdulwahed, M.; Nagy, Z. K. Applying Kolb's Experiential Learning Cycle for Laboratory Education. Journal of Engineering Education 2009, 98 (3), 283-294.

[3] Zhuang, J.; Chen, C.; Wang, J. Redesigning Building Thermal Science Education Through Inquiry-Based Experiential Learning. Buildings 2024, 14 (11), 3455.

PEE019: Beam Bending Rig Project: Bringing It All Together

Steven J. Hammer[1,*], Theo Lim[1]

[1] Mechanical Engineering, Heriot Watt University, Edinburgh, UK

* Presenting author: s.hammer@hw.ac.uk

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.

References

[1] Healey, M.; Healey, R. *Embedding Active Learning into Your Teaching Practice*. https://heriotwatt.sharepoint.com/sites/lta/Digital Education/ (accessed 2026-02-10).

[2] Budynas, R. G. *Shigley's Mechanical Engineering Design*, 8th ed.; McGraw Hill Higher Education, 2009.

[3] *Results: Measurement of Young's modulus*. Dissemination of IT for the Promotion of Materials Science (DoITPoMS). https://www.doitpoms.ac.uk/tlplib/thermal-expansion/results1.php (accessed 2026-02-27).

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

Llewellyn Morse[1,*], Zareena Gani[1], Marilize Everts[1], Christian Klettner[1]

[1] Department of Mechanical Engineering, Faculty of Engineering Science, University College London, London WC1E 6BT, UK, United Kingdom

* Presenting author: l.morse@ucl.ac.uk

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].

References

[1] Prince, M. Does Active Learning Work? A Review of the Research. J. Eng. Educ. 2004, 93, 223-231.

[2] Kolb, D. A. Experiential Learning: Experience as the Source of Learning and Development; Prentice Hall: Englewood Cliffs, NJ, 1984.

[3] Freeman, S.; Eddy, S. L.; McDonough, M.; Smith, M. K.; Okoroafor, N.; Jordt, H.; Wenderoth, M. P. Active Learning Increases Student Performance in Science, Engineering, and Mathematics. Proc. Natl. Acad. Sci. U.S.A. 2014, 111, 8410-8415.

PEE021: MIRTE: Choose Your Own (Robot) Adventure

Martin Klomp[1,*], Arend-Jan van Hilten[1], Leah Ridgway[2], Gillian Saunders-Smits[1], Amelia C. Jordan[2]

[1] Cognitive Robotics, Mechanical Engineering, Delft University of Technology, Delft 2628CD, The Netherlands

[2] School of Electronic Engineering, Dublin City University, Dublin 9, Ireland

* Presenting author: M.Klomp@TUDelft.nl

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.

References

[1] Klomp, M.; Araffa, K.; Saunders-Smits, G. MIRTE: An Affordable, Open, Mobile Robot Education Platform. In Proceedings of the 52nd Annual Conference of SEFI; Lausanne, Switzerland, 2024.

[2] Klomp, M.; Claij, C.; Saunders-Smits, G. N. Meet MIRTE—Using Affordable Open Science Robots in Engineering Education. In Proceedings of the SEFI 53rd Annual Conference; Tampere, Finland, 2025.

[3] Ridgway, L.; Jordan, A.; From Capstone to Career: Navigating the Uncertainty of Open-Source Robotics in the Engineering Design Process. Abstract SMEC STEM Education Conference, Dublin Ireland, 2026.

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

Nuttakit Wilairatanaporn[1,*], Wael AlSaafin[2]

[1] School of Engineering, University of Warwick, Coventry CV4 7AL, United Kingdom

[2] Warwick Manufacturing Group, University of Warwick, Coventry CV4 7AL, United Kingdom

* Presenting author: nuttakit.wilairatanaporn@warwick.ac.uk

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].

References

[1] Ali, Farah & Abbas, Nizar. (2024). Adaptive Cruise Control System: A Literature Survey. Journal of Engineering. 30. 239-272.

[2] International Organization for Standardization. (1993). Road Vehicles—Interchange of Digital Information—Controller Area Network (CAN) for High-Speed Communication (ISO 11898:1993).

[3] Baillieul, J.; Antsaklis, P. J. (2007) Control and Communication Challenges in Networked Real-Time Systems. Proc. IEEE. 95 (1), 9–28.

[4] Natale, M.D., Zeng, H., Giusto, P., Ghosal, A. (2012). The CAN 2.0b Standard. In: Understanding and Using the Controller Area Network Communication Protocol.

[5] AUTOSAR. (2024) Explanation of Error Handling on Application Level; AUTOSAR Classic Platform (CP) Explanation.

[6] HPL, S. C. (2002). Introduction to the controller area network (CAN). Application report SLOA101, 1-17.

[7] Robert Bosch GmbH. (1991) CAN Specification Version 2.0, Part B: Extended Frame Format. p 61.

[8] Sababha, B. H.; Alqudah, Y. A.; Abualbasal, A.; AlQaralleh, E. A. (2016) Project-Based Learning to Enhance Teaching Embedded Systems. Eurasia J. Math. Sci. Technol. Educ. 12 (9), 2575–2585.

[9] L. D. Feisel and A. J. Rosa. (2005). The Role of the Laboratory in Undergraduate Engineering Education, Journal of Engineering Education, vol. 94, no. 1, pp. 121–130.

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

Sol C. Costa Pereira[1,*], A. Marzano[1], N. Shearer[1]

[1] School of Computing, Engineering & the Built Environment, Merchiston Campus, Edinburgh Napier University, 10 Colinton Road, Edinburgh EH10 5DT, UK

* Presenting author: c.costapereira@napier.ac.uk

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].

References

[1] Gutiérrez-Pulido, H.; Orozco-Rodríguez, C. The Contribution of Professional Internships to the Academic Development of Engineering and Science Students: A Case Study. Front. Educ. 2025, 10, 1563361

[2] Linn, M. C.; Palmer, E.; Baranger, A.; Gerard, E.; Stone, E. Undergraduate Research Experiences: Impacts and Opportunities. Science 2015, 347 (6222), 1261757.

[3] Wylie, C. D.; Gorman, M. E. Learning in Laboratories: How Undergraduates Participate in Engineering Research. In Proceedings of the American Society for Engineering Education; American Society for Engineering Education: Salt Lake City, 2018

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

James R. Croxford[1,*], Andrew M. Jones[1]

[1] Engineering, Harper Adams University, Edgmond, Shropshire, TF10 8NB, England

* Presenting author: jcroxford@harper-adams.ac.uk

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.

References

[1] Arnold, L.; Croxford, J. Is It Time to Stop Talking About Authentic Assessment? Teach. High. Educ. 2024, 30 (3), 735–743

[2] Ajjawi, R.; Tai, J.; Bearman, M.; Boud, D.; Dollinger, M.; Hayes, A. M. The Multiplicity of Authenticity in Higher Education Assessment. Teaching in Higher Education 2025 30 (3), 583–591.

[3] McArthur, J. Rethinking Authentic Assessment: Work, Well-Being, and Society. High. Educ. 2023, 85 (1), 85–101

[4] Fawns, T.; Bearman, M.; Dawson, P.; Nieminen, J. H.; Ashford-Rowe, K.; Willey, K.; Jensen, L. X.; Damşa, C.; Press, N. Authentic Assessment: From Panacea to Criticality. Assess. Eval. High. Educ. 2024, 50 (3), 396–408

[5] Ashford-Rowe, K.; Herrington, J.; Brown, C. Establishing the Critical Elements that Determine Authentic Assessment. Assess. Eval. High. Educ. 2014, 39 (2), 205–222

[6] Ornellas, A.; Falkner, K.; Edman Stålbrandt, E. Enhancing Graduates' Employability Skills Through Authentic Learning Approaches. High. Educ. Skills Work-Based Learn. 2018, 9 (1), 107–120

[7] Chan, C. K. Y.; Chen, S. W. Student Partnership in Assessment in Higher Education: A Systematic Review. Assess. Eval. High. Educ. 2023, 48 (8), 1402–1414

[8] Carless, D. From Teacher Transmission of Information to Student Feedback Literacy: Activating the Learner Role in Feedback Processes. Act. Learn. High. Educ. 2020, 23 (2), 143–153

[9] Carless, D.; Boud, D. The Development of Student Feedback Literacy: Enabling Uptake of Feedback. Assess. Eval. High. Educ. 2018, 43 (8), 1315–1325

[10] Whittam, S. Transforming Assessment Design: Increasing Inclusivity Through Authentic Assessment. In Education Without Boundaries; Herb, A., Lloyd, C., Richardson, A., Corino, M.-T., Eds.; University of Newcastle: Newcastle, NSW, Australia, 2025; pp 155–168

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

M.C. Levelsey[1,*], J. Drake[1], J.F. Gallagher. D.B. Trowsdale[1]

1 School of Mechanical Engineering, University of Leeds, Leeds LS29 9JT UK

* Presenting author: m.c.levesley@leeds.ac.uk

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.

References

[1] Ben Hanson, Peter Culmer, Justin Gallagher, Kate Page, Elizabeth Read, Andrew Weightman, Martin Levesley, ReLOAD: Real Laboratories Operated at a Distance, IEEE Transactions on Learning Technologies 2009, Vol. 2, Issue. 4, Pages: 331 - 341

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

Matthew Blacklock[1*], Chris Connor[1]

[1] School of Engineering, Physics and Mathematics, Northumbria University, Newcastle upon Tyne NE1 8ST, United Kingdom

* Presenting author: matthew.blacklock@northumbria.ac.uk

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

M. Zupančič[1,*], J. Slavič[1], F. Pušavec[1]

[1] University of Ljubljana, Faculty of Mechanical Engineering, Aškerčeva 6, SI-1000 Ljubljana, Slovenia

* Presenting author: matevz.zupancic@fs.uni-lj.si

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.

References

[1] Prince, M. Does Active Learning Work? A Review of the Research. J. Eng. Educ. 2004, 93, 223–231.

[2] Kolb, D. A. Experiential Learning: Experience as the Source of Learning and Development; Prentice Hall: New Jersey, 1984.

[3] Freeman, S.; Eddy, S. L.; McDonough, M.; Smith, M. K.; Okoroafor, N.; Jordt, H.; Wenderoth, M. P. Active Learning Increases Student Performance in Science, Engineering, and Mathematics. Proc. Natl. Acad. Sci. 2014, 111, 8410–8415.

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

Rola Saad[1,*]

[1] Department of Medical Physics and Biomedical Engineering, University College London, London, UK

* Presenting author: r.saad@ucl.ac.uk

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.

References

[1] G. Tembrevilla, A. Phillion, and M. Zeadin, "Experiential learning in engineering education: A systematic literature review," J. Eng. Educ., Wiley, 2024. doi:10.1002/jee.20575. Available: https://onlinelibrary.wiley.com/doi/full/10.1002/jee.20575

[2] C. M. Rathnayaka, "Preparative pre-laboratory online resources for effectively managing cognitive load in engineering labs," Eur. J. Eng. Educ., Taylor & Francis, 2024. Available: https://www.tandfonline.com/doi/full/10.1080/03043797.2023.2204813

[3] A. Van den Beemt, J. Van den Watering, and M. Bots, "Active learning and student engagement in engineering laboratories," J. Eng. Educ., vol. 109, no. 3, pp. 508–555, 2022. Available: https://pmc.ncbi.nlm.nih.gov/articles/PMC9372942/

[4] M. Andersson, "Peer review of laboratory reports for engineering students," Master's thesis, 2018. Available: http://www.diva-portal.org/smash/get/diva2:1297429/FULLTEXT01.pdf

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

Nathaniel Dacombe[1], Steve Bull[1], Steve Greedy[1]

[1] Department of Electrical and Electronic Engineering, Faculty of Engineering, University of Nottingham, Nottingham. NG7 2RD, UK

* Presenting author: Nathaniel.dacombe@nottingham.ac.uk

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.

References

Fallows, D., Bull, S. and Greedy, S., 2022. ‘Electrical and Electronic Engineering: Integrating practical skill development into the course structure’, *Practical Engineering Education (PEE) 2022*, Sheffield, UK.

Fallows, D. and Greedy, S., 2022. ‘Redesign of Practical Electrical and Electronic Engineering Project Modules in Response to COVID’, *Practical Engineering Education (PEE) 2021*, Sheffield, UK.

Greedy, S., Bull, M., Sumner, M. and Fallows, D., 2019. ‘PBL in Applied Electrical and Electronic Engineering Design’, presented at *EPC/IET: New Approaches to Engineering Higher Education*, London, UK, November.

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

Sijie Zhou[1,*], David P. Reid[1], Dani Orejon[2], Timothy D. Drysdale[1]

[1] Institute for Imaging, Data and Communications, School of Engineering, University of Edinburgh, Edinburgh, UK

[2] Institute for Multiscale Thermofluids, School of Engineering, University of Edinburgh, Edinburgh, UK

* Presenting author: s2342374@ed.ac.uk

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.

References

[1] I. A. Udugama, C. Bayer, S. Baroutian, K. V. Gernaey, W. Yu, and B. R. Young, 'Digitalisation in chemical engineering: Industrial needs, academic best practice, and curriculum limitations', Educ. Chem. Eng., vol. 39, pp. 94–107, Apr. 2022, doi: 10.1016/j.ece.2022.03.003.

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

Daniel Orejon[1,*], Ignacio Tudela-Montes[2], Glen McHale[1]

[1] School of Engineering, Institute for Multiscale Thermofluids, University of Edinburgh, King's Buildings, Mayfield Road, Edinburgh EH9 3JL Scotland, United Kingdom

[2] School of Engineering, Institute for Materials and Processes, University of Edinburgh, King's Buildings, Mayfield Road, Edinburgh EH9 3JL Scotland, United Kingdom

* Presenting author: d.orejon@ed.ac.uk

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.

References

[1] Daniel Orejon, Rubric grades simplification and marking scheme-feedback unification for best practice in (Chemical) Engineering Laboratories, The University of Edinburgh Teaching Matters Blogs, 2025. Link.

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

Ciara Golden[1] and Kevin J. Hanley[1,*]

1 Chemical Engineering, School of Engineering, The University of Edinburgh, Edinburgh EH9 3FG, UK

* Presenting author: k.hanley@ed.ac.uk

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

[1] TSC Simulation, 3D SIM 8000 Three Phase Separator: https://www.tscsimulation.com/products/interactive-virtual-plant/3d-sim-8000-three-phase-separator/ (accessed 9 Mar. 2026)

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

Amelia Wilkinson[1,*], Jackie Liang[1], Zain Mohamed[1]

[1] Engineering for Change E4C, The University of Edinburgh, School of Engineering, EH9, United Kingdom

* Presenting author: a.wilkinson-5@sms.ed.ac.uk

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.

References

[1] *E4C*. Engineering4change.co.uk. https://engineering4change.co.uk (accessed 2026-03-30)

[2] *SPE Aberdeen*. SPE Aberdeen. https://www.spe-aberdeen.org/events/spe-offshore-europe-2025.

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

Dave Laurenson[1]

[1] School of Engineering, University of Edinburgh, Edinburgh EH8 9YL, United Kingdom

* Presenting author: Dave.Laurenson@ed.ac.uk

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

[1] Nils Höehner, Julien Rodewald, Mark Oliver Mints, and Valentin Kammerlohr. "The next step of digital laboratories: Connecting real and virtual world". In Proceedings of the 17th ACM SIGGRAPH International Conference on Virtual-Reality Continuum and its Applications in Industry (VRCAI '19). Association for Computing Machinery, New York, NY, USA, 2019, Article 57, 1–2. https://doi.org/10.1145/3359997.3365727.

[2] J. Pirker, E. Loria, S. Safikhani, A. Künz, and S. Rosmann, "Immersive Virtual Reality for Virtual and Digital Twins: A Literature Review to Identify State of the Art and Perspectives", *2022 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, Christchurch, New Zealand, 2022, pp. 114-115, https://dx.doi.org/10.1109/VRW55335.2022.00035.

[3] DP Reid, "Student-facing learning analytics dashboard for remote laboratories in engineering education", PhD Thesis, University of Edinburgh, 2024. http://dx.doi.org/10.7488/era/4899.

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

Gianluca Lavalle[1,*]

[1] Mines Saint-Etienne, Univ. Lyon, CNRS, UMR 5307 LGF, Centre SPIN, F-42023 Saint-Etienne, France

* Presenting author: gianluca.lavalle@emse.fr

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

[1] Nilsson, S., Bolander Laksov, K., Samuelsson, J., Regnér, S. (2025). Students' Reasons for Absence in First-cycle Engineering Education – an Interview Study. Media-Tryck, Lund University, Sweden. https://www.lth.se/fileadmin/cee/genombrottet/web_version_rapport_nr_4.pdf

[2] Credé, M., Roch, S. G., Kieszczynka, U. M. (2010). Class Attendance in College: A Meta-Analytic Review of the Relationship of Class Attendance With Grades and Student Characteristics. Rev. Educ. Res., 80.

[3] Mathijssen, A. J. T. M., Lisicki, M., Prakash, V. N., Mossige, E. J. L. (2023). Culinary fluid mechanics and other currents in food science. Rev. Mod. Phys., 95.

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

Duncan Dockar[1,*], Clara Stirling[1], Sritay Mistry[2], Jacqueline Misfud[3], Saikat Datta[4], Laura Cooper[5], and Rohit Pillai[1]

[1] Institute for Multiscale Thermofluids, School of Engineering, University of Edinburgh, Edinburgh, EH9 3FB, UK

[2] Centre for Advanced Powertrains and Fuels, Brunel University of London, Uxbridge UB8 3PH

[3] Institute of GeoEnergy Engineering, Heriot-Watt University, Edinburgh, EH14 4AS, UK

[4] Faculty of Science and Engineering, Swansea University, Bay Campus, SA1 8EN, Swansea, UK

[5] Warwick Medical School, University of Warwick, Coventry, CV4 7AL, UK

* Presenting author: d.dockar@ed.ac.uk

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.

References

[1] Supponen, O.; Obreschkow, D.; Tinguely, M.; Kobel, P.; Dorsaz, N.; Farhat, M., Scaling laws for jets of single cavitation bubbles, J. Fluid Mech., 2016, 802, 263–293.

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

Katherine Dunn[1,*], Zak Campbell-Lochrie[1], Calum Melrose[1], Khushboo Pandey[1], Filipe Teixeira Dias[1], Hannah Chalmers[1], Eddie McCarthy[1], Andy Downes[1], Camilla Thomson[1], Dave Laurenson[1], Amer Syed[1], Andrew Brown[1], Chris Sturgeon[1], Jane Blackford[1], Ricky Carvel[1]

[1] School of Engineering, University of Edinburgh, King's Buildings, Edinburgh, Scotland, U.K

* Presenting author: k.dunn@ed.ac.uk

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

[1] Engineering Council, Accreditation of Higher Education Programmes (AHEP) Standard, Fourth Edition (2020) http://engc.org.uk/resources-and-guidance/education-and-skills/higher-education-programmes

[2] Scottish Credit and Qualifications Framework Partnership, SCQF, https://scqf.org.uk/the-framework/interactive-framework/

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

David Garcia Cava[1,*], David Reid[1], Livio Gibelli[1], Andrew Brown[1] and Imogen Heard[1]

[1] School of Engineering, University of Edinburgh, Edinburgh EH111QP, United Kingdom

* Presenting author: david.garcia@ed.ac.uk

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

James E. Pickering[1,*] and George Amarantidis[2]

[1] Harper Adams University, Edgmond, UK

[2] MathWorks, Cambridge, UK

* Presenting author: jpickering@harper-adams.ac.uk

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

Henry Gomez Zeballos[1,*], David P. Reid[1], Tim Stratford[2], Tim Drysdale[1]

[1] Institute for Imaging, Data and Communication, School of Engineering, University of Edinburgh, UK

[2] Institute for Infrastructure and Environment, School of Engineering, University of Edinburgh, UK

* Presenting author: s2654424@ed.ac.uk

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

[1] Cardoso, A.; Leitão, J.; Teixeira, C. Using the Jupyter Notebook as a Tool to Support the Teaching and Learning Processes in Engineering Courses. The Challenges of the Digital Transformation in Education 2019, 227–236. https://doi.org/10.1007/978-3-030-11935-5_22

[2] Shute, V. J.; Rahimi, S. Review of Computer-Based Assessment for Learning in Elementary and Secondary Education. Journal of Computer Assisted Learning 2017, 33 (1), 1–19. https://doi.org/10.1111/jcal.12172.

[3] Reid, D. P.; Drysdale, T. D. Student-Facing Learning Analytics Dashboard for Remote Lab Practical Work. IEEE Transactions on Learning Technologies 2024, 1–14. https://doi.org/10.1109/tlt.2024.3354128.

PEE042: Stirrer Remote Labs in Chemical Engineering Design 1

Daniel Orejon[1,*], Andrew Brown[2], David Reid[2], Imogen Heard[2] Glen McHale[1] and Timm Drysdale[2]

[1] School of Engineering, Institute for Multiscale Thermofluids, University of Edinburgh, King's Buildings, Mayfield Road, Edinburgh EH9 3JL Scotland, United Kingdom

[2] School of Engineering, Institute for Imaging, Data and Communication, University of Edinburgh, King's Buildings, Mayfield Road, Edinburgh EH9 3JL Scotland, United Kingdom

* Presenting author: A.Brown@ed.ac.uk & d.orejon@ed.ac.uk

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

[1] R. Graham, 'The global state of the art in engineering education', Mass. Inst. Technol. MIT Rep. Mass. USA, 2018.

[2] Chemical Engineering Design 1 Laboratory Manual and CHEE08021 Degree Regulation & Programmes of Study 2025/2026, School of Engineering, The University of Edinburgh, 2025. Link.

PEE043: Remote Refrigeration Lab and Calculations App in Thermodynamics

Rachel A Schwind[1,*], Sijie Zhou[2,*], David Reid[2], Dani Orejon Mantecon[1], Tim Drysdale[2]

[1] Institute for Multiscale Thermofluids, School of Engineering, University of Edinburgh, Edinburgh, UK

[2] Institute for Imaging, Data & Communications, School of Engineering, University Edinburgh, Edinburgh, UK

* Presenting author: rschwind@ed.ac.uk & S.Zhou-41@sms.ed.ac.uk

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.

References

[1] R. Graham, ‘The global state of the art in engineering education’, Mass. Inst. Technol. MIT Rep. Mass. USA, 2018.

[2] N. Reid and I. Shah, ‘The role of laboratory work in university chemistry’, Chem. Educ. Res. Pract., vol. 8, no. 2, pp. 172–185, 2007, doi: 10.1039/B5RP90026C.

[3] B. Smyser and S. Tariq, ‘After Lab Ends: How Students Analyze and Interpret Experimental Data’, in 2016 ASEE Annual Conference & Exposition Proceedings, New Orleans, Louisiana: ASEE Conferences, Jun. 2016, p. 26541. doi: 10.18260/p.2654

PEE044: LiaScript for real and virtual hardware control

David S. Croft[1,*], Sulakshan Rajendran[1]

1 WMG, University of Warwick, Coventry CV4 7HP, UK

* Presenting author: david.croft@warwick.ac.uk

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

[1] Dietrich, A. LiaScript: A Domain-Specific-Language for Interactive Online Courses. International Association for Development of the Information Society 2019.

[2] Web Serial API | MDN. https://developer.mozilla.org/en-US/docs/Web/API/Web_Serial_API.

PEE045: Project-Based Learning Through Undergraduate Research Internships

Yolanda Sanchez Vicente[1,*] and Nur Aina Latifah Binti Umar[1]

[1] School of Engineering, Physics and Mathematics, Northumbria University, Newcastle upon Tyne NE1 8ST, United Kingdome

* Presenting author: Yolanda.vicente@northumbria.ac.uk

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

[1] Sanchez-Vicente, Y.; Bismilla, A.; Ismail, I.; Soudari, R.; Mohamed, M.; Gonzalez, M.A.; Tenorio, M.-J.; D'Oliveira, E.J.; Costa, S.C. Thermodynamic of Phase Change Materials Based on Stearic Acid with Graphene Nanoplatelets. In Proceedings of the 33rd European Symposium on Applied Thermodynamics ESAT 2024, Edinburgh, UK, 9–12 June 2024.

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

Ignacio Tudela[1,*], Andrejs Mezaraups[1], Blessings G Malimusi[1],

[1] Institute for Materials and Processes, School of Engineering, University of Edinburgh, Edinburgh EH9 3FB, United Kingdom

* Presenting author: ignacio.tudela@ed.ac.uk

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.

References

[1] Fuller, T. F.; Harb, J. N. Electrochemical Engineering, 1st ed.; John Wiley & Sons, 2018.

[2] Kempler, P. A.; Boettcher, S. W.; Ardo, S. Reinvigorating Electrochemistry Education. iScience 2021, 24 (5), 102481. https://doi.org/10.1016/j.isci.2021.102481.

[3] Carmo, M.; Fritz, D. L.; Mergel, J.; Stolten, D. A Comprehensive Review on PEM Water Electrolysis. Int. J. Hydrogen Energy 2013, 38 (12), 4901–4934. https://doi.org/10.1016/j.ijhydene.2013.01.151.

[4] Barbir, F. Fuel Cell Electrochemistry. In PEM Fuel Cells: Theory and Practice; Academic Press, 2005; pp 33–72. https://doi.org/10.1016/B978-012078142-3/50004-5.

[5] Tudela, I.; Bößl, F.; Menzel, V. C. Creating a New Electrochemical Engineering Course from Scratch: From Defining Learning Outcomes to Overcoming Teaching Challenges During a Pandemic. ECS Meeting Abstracts 2021, MA2021-02 (51), 1511. https://doi.org/10.1149/MA2021-02511511mtgabs.

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

John Turner[1,*]

[1] Department of Chemical and Environmental Engineering, University of Nottingham, Nottingham, United Kingdom NG7 2TQ, UK

* Presenting author: John.turner@nottingham.ac.uk

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.

References

[1] Nikolic, S., Ros, M., Jovanovic, K., and Stanisavljevic, Z. European journal of engineering education, 2021, 46(6), 1141-1162.

[2] Drljaca, D., Latinović, B., Stankovic, Z., & Cvetković, D., ADDIE model for development of e-courses, 2017, https://doi.org/10.15308/Sinteza-2017-242-247

PEE048: Digital First Labsheets

Andrew Garrard1[,*], Edward Browncross[1]

[1] Centre for Engineering Education, University of Sheffield, Sheffield S10 2TN, UK

* Presenting author: a.garrard@sheffield.ac.uk

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

Karla G. Cedano-Villavicencio[1,*]

[1] Innovation and Futures Lab, Instituto de Energías Renovables, UNAM, Temixco 62580, Mexico

* Presenting author: kcedano@ier.unam.mx

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

Bianca Griech[1], Valérie Varney[2]

1 TH Köln University of Applied Sciences, Cologne 50679, Germany

2 TH Köln University of Applied Sciences, Cologne 50679, Germany

* Presenting author: bianca.griech@th-koeln.de

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

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.

References

1. Ciolacu, M. I.; Alves, G. R.; Terkowsky, C.; Zoubi, A. Y.; Boettcher, K. E. R.; Pozzo, M. I.; Kist, A. A. Developing Future Skills in Engineering Education for Industry 5.0: Enabling Technologies in the Age of Digital Transformation and Green Transition. In Open Science in Engineering; Auer, M. E., Langmann, R., Tsiatsos, T., Eds.; Lecture Notes in Networks and Systems Vol. 763; Springer Nature Switzerland, 2023, pp 1019–1031. DOI: 10.1007/978-3-031-42467-0_94.

2. Hamming, R. R. Art of Doing Science and Engineering; CRC Press, 1997. DOI: 10.1201/9781482283198.

3. Gomes, L.; Bogosyan, S. Current Trends in Remote Laboratories. IEEE Trans. Ind. Electron. 2009, 56 (12), 4744–4756. DOI: 10.1109/TIE.2009.2033293.

4. Stifterverband, Ed. Digitalisierung in Studium und Lehre gemeinsam gestalten; Springer Fachmedien Wiesbaden: Wiesbaden, 2021. DOI: 10.1007/978-3-658-32849-8.

5. Reid, D. P.; Burridge, J.; Lowe, D. B.; Drysdale, T. D. Open-source remote laboratory experiments for controls engineering education. International Journal of Mechanical Engineering Education 2022, 50 (4), 828–848. DOI: 10.1177/03064190221081451.

6. Grodotzki, J.; Ortelt, T. R.; Tekkaya, A. E. Remote and Virtual Labs for Engineering Education 4.0. Procedia Manufacturing 2018, 26, 1349–1360. DOI: 10.1016/j.promfg.2018.07.126.

EXTENDED 2-PAGES ABSTRACTS

Extended 2-Pages 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