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## **The impact of remote and virtual laboratories in engineering education: A Workshop**

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Current developments in information and communication technology (ICT) can be successfully embedded in the pedagogical design of engineering laboratories. This can open new horizons in the learning experience and widen participation. The development of virtual and remote laboratories are examples of embedding modern ICT in education which are becoming more and more widely accepted in engineering education. This workshop aims to corroborate the impact of virtual and remote laboratories on the development of knowledge and transferable skills in engineering students. The workshop will commence with introductions to the concepts of remote and virtual laboratories describing the pedagogical framework that supports the applications of these technologies to traditional and non-traditional students (ZKN/REB/ER).

The new concept of 'TriLab', a framework that combines real, virtual and remote laboratories to maximize the learning experience of students, is presented. Statistical results will be presented on the impact of the TriLab approach on students' understanding. The use of the TriLab concept in undergraduate teaching in the Chemical Engineering Department at Loughborough University will be presented with a demonstration of the Process Control TeleLab, which will involve the active participation of the audience with potential for using a remote voting system (MA and ZKN).

Following the participants use of the activities, a presentation on the role of remote experiments for widening participation will be introduced. The system was originally developed to allow remote access to real experimental equipment (ReLOAD) but has the added values that it can also be used to support the learning needs of this diverse student base. ReLOAD was incorporated into two different courses at both UCL and Leeds University both with high proportions of WP students and both the use of the tool and feed back from students was recorded. The tool can also be shown to demonstrate specific support for issues encountered by WP students (ER). Following this, the extremely innovative work on remote laboratories pioneered at Curtin, Perth will be introduced. This will consider the strategic approach to the use of remote labs and the fact that remote labs cannot be considered to be second best (EL). Again there will be a timed opportunity to gain experience using these applications (ER/EL).

The session will close with a round table discussion on the advantages and caveats of remote and virtual laboratories in engineering education (chaired by ZKN and REB).

**Outline of the Workshop activities with Timings**

Topic	Lead	Activity	Timing
Introduction to Workshop	ZKN	Setting out the agenda for the packed session	0-5 minutes
Virtual Laboratories for Distance Learning	REB	Introduction to the use of virtual labs in distance learning engineering MSc. Model developed over six years.	5-15 minutes
Trilab	MA	Introduction to Concept of combining hands-on, virtual and remote laboratories	15-25 minutes
Trilab and virtual labs	ZKN/REB/MA	Participants make use of remote and virtual laboratories	25-50 minutes
Widening participation –RE-Load remote laboratory	ER	How remote laboratories could be used to widen access for non traditional students	50-60 minutes
Making it real	EL	The remote laboratory model at Curtin Perth	60-70 minutes
Use of remote labs	ER/EL	Participants make use of 2nd set of remote laboratories	70-90
The opportunities and barriers for virtual and remote laboratories	REB/ZKN	Participants in groups spend time discussing Strengths, issues. Possibly look at one question. How to develop and share resources?	90-110 minutes
Round up	ZKN	Wrap up	110-120 minutes

**Actors**

ZKN – Zoltan Nagy (Lboro)

REB - Richard Blanchard (Lboro)

ER – Liz Read (RAE)

MA - Mahmuod Abdulwahed (Lboro)

EL – Euan Lindsay (Curtin, Perth)