

Digital Education in Engineering Practical Work

Using remote laboratories and learning analytics to increase task completion

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SUMMARY

Laboratory work entered higher education just over 200 years ago, displacing the traditional lecture demonstration. With some drama, the transition played out over a period of some decades, but the key event was the opening of a laboratory course at the University of Giessen, Germany in 1824, and the resulting exodus of students from the lecture halls of Prof Thomas Hope at the University of Edinburgh, in Scotland, amongst others [1]. Since then, laboratory courses have become the default approach for science, technology, and engineering subjects. No change is perfect, and by the 1980s, there was already tension between academics assuming labs were vital, students finding them “boring ... to go through the motions ... without clear purpose”, and accountants saying they were expensive [2].

This tension has to this day not yet been resolved, and is instead under increasing pressure from mismatches between previous political directives to expand the University sector, and the way in which it is funded, leading to a new focus on digital education approaches [3]. The scaling up of student cohorts on campuses that were built in an earlier era, in tight city centre campuses, can be addressed in an instrumental sense by using alternative delivery techniques such as remote laboratories [4]. While there is a well-established international network of academics and commercial interests supporting remote laboratories, such as IAOE, GOLC, VISIR, Crosslabs, and Labsland, it is probably fair to say that remote laboratories remain a niche activity [5].

An aspect of this may be the difficulty in operating a large-scale high reliability system. We currently operate over 180 experiments simultaneously, using our own open-source system practable.io, with experiments covering courses in electrical, mechanical, civil and chemical engineering, with audiences ranging from secondary school, vocational training, and higher education at first – fifth year undergraduate, while post graduates do experiment development projects. This has been essential to our own teaching offering. Looking to the future, it is possible to consider that simply replacing one form of practical work delivery with another, whilst retaining the same

lab sheets and the same report-based assessment (while useful) is unlikely to adequately address the development of additional skills that students need for their future careers [6], ever more so the case in a world with widely available generative artificial intelligence (genAI) that can quickly write reports.

We can partially address issues associated with student numbers growing by finding ways to give useful, formative feedback to students when they need it (on-demand). For example, in our own work, we found that reflecting back to students in visual form the actions they had taken toward various tasks resulted in nearly double the task completion rate [7]. This also provides a mechanism to observe and assess student process, which is important to focus on when the considering the outputs alone makes it hard to distinguish between student and genAI contributions. In this talk I will review our system, experiments, and educational research, and attempt to convince you that there are benefits to be had adopting digital education approaches, in terms of student and staff experience and in evolving education for the genAI era.

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