Inclusion of research labs in Engineering as learning playgrounds

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Abstract

Traditional teaching practices in Ireland for "hard"-science subjects, such as Physics or Engineering, are still prevalently based on whiteboard content delivery, PowerPoint-based methods, and sometimes, within under-funded purposed-built teaching labs, leaving very little manoeuvre or willingness to incorporate student interaction, in addition to a strong focus on end of semester exam-based assessment of learning. Very often any deviation from traditional methods of teaching and assessment are perceived as "dumbing down" the course.

The proposal of this Lightning Talk is to show how enabling flexibility in the teaching environment, by incorporating either topical research discussions or bringing a high-tech research lab to a teaching module, can stimulate student engagement, curiosity, discovery and learning. Moreover, the talk will also contain a discussion on using different assessment techniques, such as consultation surveys and reports, where a richer picture of true understanding can be drafted, and compare outcomes between report-based and exam-based types of assessment, showing no signs of "dumbing down".

Methods

Although varied methodologies were used in teaching Photonics at the Department of Electronic Engineering in UCC, this paper will focus on incorporating a state-of-the-art research lab space away from main campus, as alternative teaching and learning environment, with a self-directed exercise and a reflective piece: formal assessment of learning through submission of report weighting 10% of total marks.

As the labs were based in Tyndall, 1.2 km away from the department (or 15-20 min walk), the reception and health and safety induction had to take place in a welcoming and friendly atmosphere. The labs were very prescriptive to allow students to familiarise themselves with a complete new environment, including new equipment and interactive approach with lecturer. A 10-page detailed instruction is given a priori to students, and this step-by-step guide is important, so they can "feel" reassured that they are in control of the experiment. There are about 20 pieces of equipment to be looked after, worth around €0.5M, but they are trusted to do the experiments under minimum supervision. As they gather data, the guide asks students to reflect upon their classroom notes and prior knowledge from previous modules to explain their observations. The lecturer was available at all times for consultation, but students were left in control of experiments. The numbers collected were not actually that important, as what counts for the report marks are the explanations of their observations.

Findings

Findings for the last two years are that students gather the expected data, they do familiarise themselves with the equipment, but not all engage with a deeper learning through connections with prior knowledge

or notes from classroom, or even further searches in the Internet or library. Figure 1(a) shows the average marks for years 2018 and 2019 for the same 4th year module. 2019 had fewer students. Student number in the picture is random, and in no particular order. On average, the marks are around 70% to 74% in each year. The standard deviation is important (deviation of the observation from the average), as there are some students which find it harder to engage with the post-lab report. But when comparing the lab report results to the actual traditional exam (for 2018), an interesting path emerges as per Figure 1(b). On average there is virtually no difference in the marks, and in each case two students brought the average down. The standard deviation is a little higher for the exam, and understandably so as the time pressure can be difficult for many students. There's no correlation of the student number in the x-axis, they are random, so one cannot correlate a student who got a lower mark in the exam with a lower mark in the report.

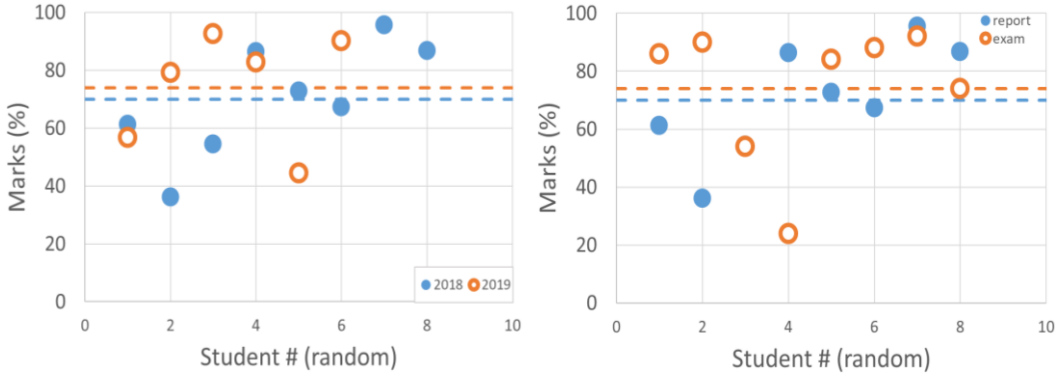

Figure 1: Marks per random student for (a) lab reports in 2018 and 2019; and (b) 2018 comparison between lab report and formal exam.

Conclusions

Figure 1 shows evidence, on average, that adding the research lab element allowing students to reflect on their own learnings did not influence marks or "dumbed down" the module. Allowing students to have a playground where they experiment with different techniques, apply prior-learning and consolidate fundamentals are of extreme value. Informal feedback is very positive, with surveys constantly requesting more labs, which will be discussed at the lightning talk. The reflective report takes away the pressure of a time-restricted exam and highlights the actual learning deficiencies to be addressed.