SCAFFOLDING LABORATORY SKILLS

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Background

The first-year physics laboratory program at UNSW Canberra has evolved over many years (Low & Timmers, 2011), in response to the commonly-experienced drivers of available resources (material and human) and student feedback (on both enjoyment and learning outcomes). Here, we report on the most recent changes: moving towards an inquiry-oriented system that employs scaffolded skill-development with a capstone assessment task.

Description of intervention

The new first semester laboratory program consists of a sequence of four fortnightly 3-hour training activities, supported by online preparatory material that focuses on skills and techniques, followed by an assessed experiment (Table 1). The physics content of each activity is deliberately very simple, so that the focus is on process and skill development. Experimental design is a theme through each activity: students are given an experimental aim and a few hints, but no method, so the program is strongly inquiry based (http://www.iolinscience.com.au/).

Table 1: Sequence of experiments

Activity	Description	Skill focus
1	Use a series of measurements in the laboratory to predict the characteristic motion of a NERF dart fired outdoors	Logbook-style record keeping
2	Use Archimedes' principle to determine density; and observe the scatter of a projectile landing on the floor	Uncertainties (meaning and propagation)
3	Determine the spring constant using Hooke's Law	Graphing
4	Determine the spring constant using an oscillation method	Experimental design
5	Assessment: use a simple pendulum to determine *g*	

The first four activities each introduce a new skill, while building on skills from previously experiments. For example, in their third activity students must keep a logbook record and calculate uncertainties, and in addition learn how to plot and draw conclusions from a graph. Students are given formative feedback on each of the first four activities, including what aspects of their work need improvement. The fifth activity is a practical assessment, in which students need to demonstrate their mastery of the laboratory skills. For the first four activities, students work in groups of decreasing size (6, 4, 3, 2); the final summative assessment task is conducted individually, under examination-like conditions.

Results

Students were invited to complete an anonymous survey at the conclusion of the final training activity. Of a total cohort of 162, 133 students completed the survey, and the results are displayed in Figure 1. On a 5-point (high-positive) Likert scale, 'enjoyment' averaged 3.7 ± 0.08, and the 'learning experience' averaged 4.1 ± 0.06. Students were also asked what we could do to improve the laboratory experience, to which the most common response was along the lines of, 'more teaching, rather than leaving us to learn for ourselves'. We see this as a positive response, because it indicates that students were being required to actively engage and think. While they may not wholeheartedly embrace this experience, it is more likely to lead to deep learning than other, more passive, learning experiences, in which students are spoon-fed easily digestible course content. Examination of their laboratory records, and in particular the final laboratory exam record, indicates that most students are gaining proficiency in the required skills through the semester.

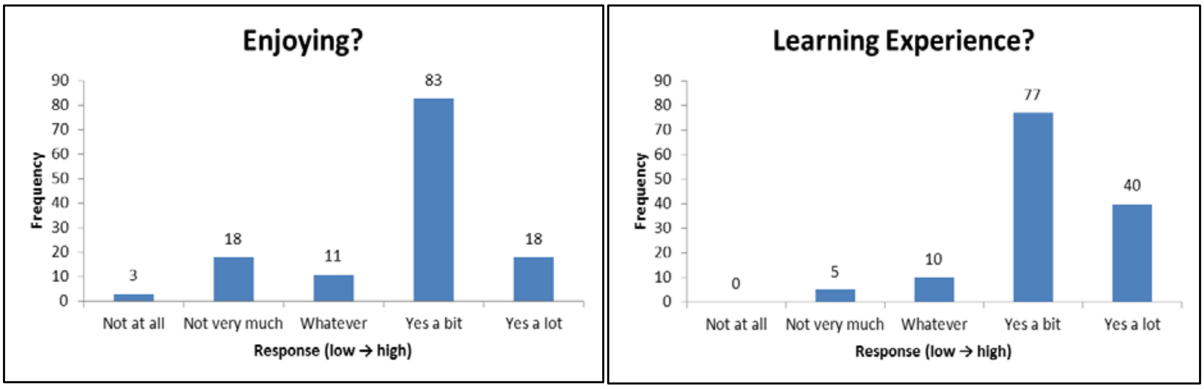

Figure 1: Distribution of student responses to the laboratory experience survey. Questions asked were, 'Are you enjoying the Physics 1A Laboratories?', and 'Are the Physics 1A Laboratories a good learning experience?'

Conclusions

By focusing on the processes of designing and performing an experiment, rather than the physics content, students' skills are built from experiment to experiment. They find this experience, on the whole, both enjoyable and effective. The skills that they have learned – to design an experiment, keep good records, perform uncertainty analyses, and use graphs to interpret data – should stand them in good stead in all their subsequent studies and work.

References

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