Evaluation of improved outcomes in physics service courses

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Background

Since the early 1960s, first year physics at the University of Tasmania in Hobart has been split into a 'mainstream' unit for students wishing to progress towards further physics studies and a terminating unit acting as a service course primarily for students in the biological and health sciences. Whilst having various names over the years, to reflect differing balances of user requirements, the generic title of Physics for Life Sciences is often used for the latter. A significant difficulty is the wide range of student backgrounds, interest and academic ability in an enrolment which has typically been around 60 to 80 students in recent years.

Our group was awarded a 1999 CUTSD grant to investigate teaching techniques in this area. The broad aim was how best to address perceptions of poor student performance in and satisfaction with the course as previously presented. The project was designed to be non-technological in nature, based on 'constructivism', building on students' prior knowledge and background, achieve a conceptual change in the students' understanding of physics using constructivism as a referent, and inculcate ideas of science as a process of inquiry. The perceived problems were:

By staff	**By students**
Variety of student courses Variety of student academic backgrounds Lack of student interest Poor SETL (Student Evaluation of Teaching and Learning) results	Difficulty of material Lack of apparent 'relevance'

The units and the student body

By 1999, 'Physics For Life Sciences' comprised the 12.5% semester 1 unit KYA171 *Applied Physics* (prerequisite: TCE Year 11 *Physical Sciences*) and its second semester follow-on unit KYA172 *Biological Physics* (prerequisite: TCE Year 12 *Physics* or KYA171). KYA171 was compulsory for Horticulture, Agriculture and Surveying students, whilst KYA172 was compulsory for Agriculture and Pharmacy students. Both units were optional for other students in the Faculty of Science and Engineering. There was thus a wide range of student backgrounds and interests.

The approaches

Using the constructivist approach to teaching we particularly sought group participation, encouragement of questions and discussion in lectures, group work in some lectures, explicit teaching of problem solving strategies, explicit checking of learning progress for student awareness and formative feedback, and identification of different learning modes.

Evaluation

Six measures were recorded: comparisons with grades in previous years; formal SETLs; staff workbooks; anecdotal comments from staff in laboratories and other conversations with students; post-hoc student focus groups; and a University Constructivist Learning Environment Survey (UCLES) (P. C. Taylor, private communication). Not surprisingly, it proved difficult to achieve unambiguous results from these data. Part, but by no means all, of the difficulties arose from differences in expectations between physicists and educationalists. The latter are accustomed to less precise results than physicists normally require from experiments. This difficulty was compounded by the use of several staff and several techniques. Nevertheless the project succeeded on almost all measures.

Final assessed grades were better, possibly significantly so, from the previous year. Grade Averages (1 = Pass, 2 = Credit, 3 = Distinction, 4 = Higher Distinction) were: (numbers of students in brackets)

	1998	1999
KYA171	1.60 (61)	1.75 (53)
KYA172	1.83 (70)	2.10 (77)

Student satisfaction, as measured by formal SETLs also improved over the previous year. The statistical reliability of this outcome is hard to confirm but it does provide a useful indicator. Of the ten questions asked of students only one showed a poorer result in 1999 than 1998, that relating to the consistency of teaching. We gained the strong impression that many students expect a consistent teaching approach through a unit and are unhappy if the approach is changed.

The *UCLES* results provided qualitative measures of student satisfaction in two categories, student learning and university teachers. They indicated, as expected, that students' perceptions of their learning environment fell short of their preferred quality in all cases. The smallest discrepancy between perceived and preferred situations was noted for negotiation and the highest for relevance of learning. Scores in the university teachers' category indicated high expectations of the quality of interpersonal relationship with physics teachers. From the constructivism perspective these results are thought-provoking, but do not suggest final strategies because of the complexity of learner-sensitive teaching.

Staff workbooks of all activities were valuable qualitatively but hard to use quantitatively. They proved to be more useful as a record of what had been attempted than as an indicator of what had been achieved.

Anecdotal comments were also of value. Most were positive. In particular, students liked the increased attention and feedback. Comments, both here and in the focus groups, also emphasised the differing perceptions of 'relevance' between students and staff. Almost all students in a physics service course want the presented material to be 'relevant'. Fewer can define or explain what they mean by this. Some mean relevant to their course, others relevant to their interests, still others seem to mean 'Engagement'.

Post-hoc student focus groups were another strong indicator. Most of the participants appreciated the constructivist techniques and the discussions that flowed from them.

Conclusions

Evaluating outcomes proved to be harder than we had expected, even though we had been aware at the outset that we could not expect the types of certainties that one requires of an experiment in the physical sciences. In particular, the discovery that different measures can give contradictory results was worrying. We did confirm, however, the pivotal role of students' backgrounds in evaluating and interpreting the effectiveness of the project. The act of measuring affects the quantity being observed!

There are two broad categories of students, those interested in building an understanding of physics and those wanting clear information in order to pass examinations. The latter predominate in our 'Physics for Life Sciences' units. Teaching must therefore be tailored to their requirements.