"Mum can't come to the phone right now – she's in the laundry doing a rat dissection"

Flexible delivery of laboratory programs in the biological sciences

Jenny Mosse and Wendy Wright, School of Applied Sciences, Monash University
jenny.mosse@sci.monash.edu.au wendy.wright@sci.monash.edu.au

The School of Applied Sciences at the Gippsland Campus of Monash University has had extensive experience in the teaching of cell biology, physiology, microbiology and biochemistry programs by distance education. Laboratory requirements in these subjects are met by off-campus students using many different approaches, including residential schools, computer simulations, independent experimentation and home laboratory kits.

History

As part of the Gippsland Institute of Advanced Education (GIAE), the School of Applied Sciences served predominantly Gippsland and Melbourne metropolitan-based students studying for diplomas and degrees in the applied sciences. Courses were first made available by distance education to service students who were employed in industries in the La Trobe Valley and therefore unable to attend traditional classes. While the basis of the theory course was delivered in print form, supplementary tutorials and the laboratory classes were held on weekends. Students attended what came to be known as "Weekend Schools" three to four times per semester. These distance education courses became attractive to people further afield and gradually the geographical range of the student base expanded.

In the late 1980's it became clear that the weekend school model was becoming unsuitable for many of the students, since the costs associated with travel to the campus (from places such as WA, NT and Tasmania) were considerable. It was decided to create a first year program which involved no on-campus attendance requirement, followed by second and third level programs where attendance requirements were blocked into concentrated residential programs.

The programs

As the School of *Applied* Sciences, we have a commitment to provide graduates with extensive training in practical skills, therefore all courses emphasise "hands on" practical work. Staff felt that this training is essential right from the start of the course, as it has a dual role: allowing students to develop skills and competencies; and encouraging them to apply their theoretical knowledge to a practical situation. The latter enhances their understanding and facilitates learning. There was a strong commitment to retain this practical emphasis in designing the new distance education programs. In upper level subjects, the (appropriate) use of computer simulations reduced the number of hours which students had to spend in classes at the University campus. This made it easier to block the remaining exercises into concentrated residential schools. At first level, the development of laboratory kits and home experiments enabled students to complete practical exercises without any travel requirement.

Computer simulations

Computer simulations are used to supplement the laboratory programs. They have been found particularly useful in areas where collecting 'real' data is impractical. For example, a natural selection simulation is used in first level Biology to explore one of the mechanisms of evolution, while a peptide sequencing simulation exposes second level Biochemistry students to experimental work that

would otherwise be outside the scope of the undergraduate laboratory. In our experience, however, computer simulations are useful only when students have some practical and theoretical competence in the area being simulated. If this is missing, it is difficult for students to follow the simulation and gain a true appreciation for what it shows – the danger is that simulations can be treated as sophisticated computer games. When used in this way, simulations may well be intellectually stimulating, but have little value in terms of training students in experimental strategy.

Residential schools
In residential schools, second and third level students complete a traditional laboratory program in a restricted time frame (3 – 6 days, depending on the subject). Because there are no timetabling restrictions (unlike on-campus laboratory classes) it is possible to start a second experiment before completing the first. This enables compression of the time taken for all exercises to be completed and, importantly, it mimics the dovetailing of activities that naturally occurs in the workplace.

Laboratory kits
Laboratory kits for the first year biology subjects, Cell Biology and Biology of Mammalian Systems, were developed by the biology teaching staff. Each staff member was asked to prepare one or two laboratory exercises addressing a particular aspect of the course. Once they were prepared, the laboratory exercises were trialled by an "intelligent non-biologist" (a Chemistry graduate) who provided detailed feedback about any procedures she felt were unclear. The laboratory guide was modified accordingly before being sent out to the first group of Distance Education (DE) students. This preparation phase was vital and a measure of its success is the fact that only minor modifications have been required since. Once the DE laboratory course was finalised, a similar on-campus laboratory program was developed. There are subtle differences between the on-campus and DE laboratory programs, primarily reflecting equipment availability, but the students are exposed to the same concepts and develop the same skills.

The Cell Biology laboratory program consists of five practical exercises, encompassing histology, enzyme activity, membrane permeability, photosynthesis and the modelling of DNA replication and protein synthesis. The Mammalian Biology laboratory program also consists of five practical exercises, encompassing salivary secretion, a rat dissection, exercise physiology, the nervous system and natural selection. Some laboratories are larger than others so contribute a larger percentage of the practical marks.

Making it work

One of the most difficult things for isolated students to overcome is their lack of confidence. Therefore the early experiments must work and the subject adviser must be contactable, understanding and able to help when problems arise. For example, the second exercise in Cell Biology requires a lot of preparation. Many students contact the subject adviser in relation to this exercise and it is essential that they receive a rapid and useful response. The experiment itself, however, is very robust and students inevitably achieve good results, despite their lack of experience. Having leapt this hurdle successfully, our experience is that students are prepared to tackle subsequent experiments, some of which are more difficult, with significantly less assistance.

The safety of the students, and of couriers responsible for delivering kits to students, must be considered. The regulations for transport of dangerous or hazardous goods dictate appropriate precautions. We generally use road transport to deliver kits because air transport regulations are very restrictive. We are unable to send complete kits overseas.

Kit components must be securely packed and clearly labelled especially when similar materials are required for different experiments. Comprehensive safety information is provided both in the kits

and in the laboratory notes. We have not been made aware of any safety problems arising during the past decade.

How successful is the kit option?

Laboratory reports for both DE and on-campus students are assessed by the same staff member and according to the same criteria. The performance of the DE cohort is at least as good as that of the on-campus students. This may reflect a whole range of motivational and other factors. The DE students obtain sensible experimental results, which they are able to interpret and explain.

Optional weekend schools are available to students of Mammalian Biology. It is interesting to note that the majority of students do not take up this option. Those who do are difficult to categorise. Some are "new starters" who have not previously undertaken tertiary study. Others lack confidence, perhaps because they have limited prior knowledge in the subject area; some just need to be reassured that they are doing the "right" thing. Others seem to enjoy the social contact and do not live at a prohibitive distance from the Gippsland campus.

Parity between on-campus and kit-based DE programs

The evolution of the first level course has meant that the on-campus laboratory program reflects the DE laboratory program, rather than the reverse. This does not mean that the laboratory programs are reduced in any way, it is just that we are careful that the experiments we have chosen to illustrate aspects of the theory course are achievable by students working at home using kits.

Although DE and on-campus students carry out the same experiments, the time commitment required by DE students is often greater, since they have to prepare their own materials, such as buffers, enzyme preparations, chromatography solvents etc. In some instances, they may also be required to source and purchase experimental materials. Chicken hearts (for enzyme extraction), acetone and unleaded petrol (for chromatography solvent) are some examples. The DE students are prepared to do this 'extra' work as they acknowledge the advantages of reduced travel and increased flexibility.

There is no distinction between on-campus and DE students in terms of grades received for practical work in the first year or in their laboratory performance in subsequent years. This would indicate that the outcomes of the programs are comparable. Student feedback shows that the DE students, themselves, do not view their experiences using the kits as inferior.

Conclusion

Kit-based laboratory programs have proved to be a viable and valuable option for first level students. Their flexibility enables distant students to choose when and where they complete the laboratory components of their course. These programs have been shown to foster the development of practical skills and competencies which are required in higher level studies in the biological sciences.