Teaching and Learning in the Laboratory: Can we do it better?

Simon Barrie, Institute for Teaching and Learning,
Ian Jamie and Scott Kable, School of Chemistry
Mark Buntine, Department of Chemistry (Adelaide University)

APCELL Workshop

Why do we teach science in the laboratory, how do we do it, and are we effective at doing it? These are important questions for academic teaching staff in the physical sciences and they require serious attention by practicing teachers. Laboratory-based teaching and learning is a fundamental component of the physical sciences curriculum in general and of the chemistry curriculum in particular. This is especially true in physical chemistry courses, where, laboratory-based teaching and learning is vital in reinforcing and making concrete abstract material. There is recognition, however, that students are not always finding their laboratory courses to be interesting and motivating, and that, as a learning experience, the courses could be improved.

The need and opportunity for a collective effort involving the resources of multiple institutions was recognised, and funding obtained, from the Committee for University Teaching and Staff Development (CUTSD, now AUTC). So the Australian Physical Chemistry Enhanced Laboratory Learning (APCELL) project commenced in early 2000. APCELL has bought together diverse physical chemistry educational expertise and resources from across 30 Australian universities. APCELL is overcoming the resource constraints of individual university chemistry departments by treating the participating institutions as a single meta-department. It has, as its aim, the development of a protocol for the design of teaching experiments, based upon sound pedagogical tenets. The result will be a suite of experiments that will facilitate improved student learning.

Through consultation with colleagues in other chemistry departments and in curriculum development units, and a consideration of the literature, it was found that the availability of resources posed a serious barrier to such curriculum review, re-development and renewal, as well as conceptions and approaches to teaching on the part of some teachers. The resource limitations are in physical resources (e.g., apparatus), specialist expertise, pedagogical expertise and active student involvement. Discussions within the Australian academic community revealed that individual institutions were making attempts to address this issue, but it was also apparent that no single institution could overcome the multiple barriers to the implementation of effective teaching and learning methods.

In planning a strategy to overcome these impediments, the project team drew upon the research literature on laboratory teaching and learning, curriculum and academic development, and curriculum change. The methods employed in the APCELL project were selected on the basis of engaging academics in reflecting on their own decisions about teaching and design of laboratories. The project method identified the need to engage participating academics at the level of their underlying ideas about teaching and learning, rather than at the level of teaching behaviours. The project aims to use processes

that will encourage participating academics to design their laboratory teaching from a learner-focused perspective rather than a teacher-focused perspective. Importantly, the project allows the outcomes of this reflection to be distributed throughout the community.

This strategy required that the project start with the participants' own ideas and conceptions of teaching, and for the participants to reflect on and challenge these, in developing the parameters for a laboratory curriculum 'template'. This template forms the core of the APCELL project. Rather than prescribe 'good' teaching practice, it aims to promote a consideration of existing teaching practices from a learner-focused perspective.

The development of the criteria that are embodied in the 'template' was the first stage of the process. The second stage of the process was the development, submission and review of laboratories for inclusion in the APCELL database. This culminated in an Experiment Workshop, held at the University of Sydney, where staff and students from the participating institutions came together to engage in an inquiry into the student learning experience of the submitted laboratories. During the workshop both teachers and students participated as learners and both contributed 'learner' evaluation data to the inquiry. At the same time the template itself was peer-reviewed and evaluated as a tool to support the review process. An extremely important aspect of this process was the inclusion of students. Many academics found that their conceptions of student approaches to experiments were challenged. Also important was getting academics back into the laboratory to allow them to experience the experiments from the perspective of a student. This again challenged their ideas of the learning experience. The student participants also found that their ideas of the philosophy and implementation of teaching experiments were open to question. It is not an overstatement to say that the workshop was a pivotal point in the project and that both staff and students, some of whom came with a certain degree of scepticism, went away with an exciting level of enthusiasm for the project.

Besides the personal and professional development of the participants of the workshop, the outcome of the workshop was the refinement of the 'template'. The next stage of the process will involve the dissemination of the revised template, along with the tools (student surveys etc), guidelines and criteria for the peer review and submission process, and the experiment database itself. This will be published on the existing APCELL website at : http://www.apcell.org/. It is envisaged that these products will further support research-led teaching investigations and inquiries, both in chemistry and the other sciences.

The tools and methods developed in the project are already being used in curriculum development, but the most important resource for further inquiry and research is the people who have participated in the APCELL project. The staff and students from the participating universities are keen to pursue the ideas and new insights they have encountered and more importantly, they have a network of colleagues to support them in this.

In conclusion, the APCELL project has developed a protocol for preparing physical chemistry undergraduate experiments. The philosophy of APCELL and implementation of the protocol has been accepted enthusiastically by a significant number of the physical chemistry teaching community and is leading to the production of a valuable resource for that community. The methods employed in the project are applicable to all areas of laboratory-based education and it is envisaged that the project will be expanded beyond its original compass.

Simon Barrie, Mark Buntine and Scott Kable are Directors of the APCELL Project. Ian Jamie is an Associate Director.