Laboratory-Based Teaching and Learning: Developing Quality Assurance Processes

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Students often indicate a preference for experiential learning methods (Boud, Cohen and Walker 1993; Boulton-Lewis 1994). Within the Chemistry curriculum, experiential learning is predominantly (but not restricted to) the laboratory practical exercise context. There are many purposes of laboratory-based teaching. Some aims are (Bennett and O'Neale 1998; Johnstone and Al-Shuaili 2001): to encourage accurate observations and careful recording; to promote simple, commonsense, scientific methods of thought; to develop manipulative skills; to give training in problem solving; to elucidate theoretical work so as to aid comprehension; to verify facts and principles already taught; to be an integral part of the process of finding facts by investigating and arriving at principles; to arouse and maintain interest in the subject; and to make phenomena more real through actual experience. Skills development encompasses; manipulative, observational, interpretative, and planning. This list may be aligned with the development of generic skills and graduate attributes that are critical for the post-tertiary success of university graduates. Laboratory-based learning is an ideal vehicle for developing: academic skills (critical thinking, problem solving, etc.); communication skills (written, oral, presentation); data handling (acquisitional, numerical, statistical); IT (data manipulation and presentation, report creation, research); self-management (time management, planning, reflection; and self-awareness) and interpersonal skills (teamwork, leadership).

If laboratory-based learning is considered fundamental to the student experience in Science education in general and in Chemistry in particular, then it might be assumed that laboratory-based learning is well aligned with students' preferred learning methods. Yet there is a considerable body of evidence to show that the potential of laboratory-based teaching and learning is not met, (Hart, Mulhall, Berry, Loughran and Gunstone 2000; Hodson 1990; and Watson 2000). Students often see the laboratory exercise as a task to be completed as quickly as possible, with the minimum possible effort (Edmondson and Novak 1993), and this attitude can defeat any attempts to use the experience as a teaching and learning tool. Students may not see the relevance of the laboratory exercise to either their coursework or anything beyond the unit of study in which they are undertaking the laboratory work. Unfortunately, there are rarely mechanisms in place to monitor the effectiveness of laboratory-based teaching and learning. That is to say, quality assurance procedures are lacking. What efforts have been made to analyse pedagogical content and embed monitoring schemes have generally met with limited success due to the constraints of limited time and limited expertise and experience in pedagogy. Thus, while laboratory-based teaching and learning is considered essential to the curriculum, little is actually known of its true effectiveness in action, and the research that has been conducted on it shows that it often does not produce the results that it is assumed to do.

Some of the known problems are:

- that students make few connections between their laboratory exercises and their coursework;
- student notes often have few, if any, explicit objectives, and typically across the curriculum they are fragmentary and inconsistent;
- staff retirements and movements result in the only extant documentation associated with the experiment being the student notes themselves; and
- guidance for demonstrators often does not extend beyond supplying the expected numerical answers, and rarely provides any indication of the learning outcomes that the students are expected to achieve, and how the demonstrators may help the students achieve them.

This project aims to raise the quality of laboratory-based learning experience of our students, and to establish methods for on-going maintenance, monitoring and improvement in laboratory-based teaching and learning within the Chemistry curriculum. This will be accomplished through the analysis and documentation of the pedagogical basis of the experiments used in teaching, and the provision of tools and methods to aid staff in using these experiments as effective teaching and learning objects.

An outcome will be a framework for the design and implementation of new teaching experiments and ethos of pedagogical awareness of laboratory-based teaching and learning amongst teaching staff. Development of generic skills and attributes by the students will be supported by identifying where in the laboratory program this development occurs, and by providing guidance to teachers for achieving that development.

This project aims to develop quality assurance processes by involving academic staff in a cycle of reflection upon their teaching practices in the laboratory program. A tool, the 'Educational Template', has been provided which supports this reflection with respect to individual experiments. By using this tool to articulate the intended learning outcomes and methods of achieving them, the quality of these experiments can be improved. More importantly, staff are able to identify the themes common over the whole laboratory program. Awareness of the issues associated with quality assurance in the laboratory program is raised through workshops, one-on-one discussions and working through the pedagogical analysis of the experiments. Departmental policy is formulated on the basis of the individual reflection and group discourse, ensuring that the staff develop a sense of ownership of the process.

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