Developing a project laboratory course in chemistry

Grainne Moran, School of Chemical Sciences, The University of New South Wales
g.moran@unsw.edu.au

Introduction

During the redesign of the BSc degree structure at UNSW in 1998-1999, we set out to develop some third year chemistry courses which were not constrained by the conventional partitioning into 'organic', 'inorganic', 'analytical' and 'physical' chemistry designations. We also wished to provide all graduating students (in both three and four year degrees) with the opportunity to do project-based experimental work. Meanwhile, consultation with employer groups consistently highlighted team work, planning, organisational and communication skills as being highly desirable in graduates, but employers generally perceived science graduates to be deficient in some of these areas. We had previous experience of running problem-solving laboratories in an advanced analytical chemistry course and this came to serve as the pilot phase in the development of the new course. This paper describes the development of the project laboratory course in chemistry, its aims and outcomes, the feedback from students and how this influenced the further development of the course.

Course development

Pilot phase
The idea for a laboratory program based on problem-solving or project work initially emerged during a review of an advanced analytical chemistry course, taken by third year chemistry majors. These students had already taken a course in instrumental analysis and it was decided that an advanced course should not merely consist of more difficult set experiments. Instead, students would be presented with an analytical problem and would develop and implement an experimental strategy to solve it. The problems were presented as scenarios that might confront an analytical chemist working in a consulting or research laboratory.

This laboratory ran for two years during which time feedback from students was almost uniformly positive, with only one student expressing a preference for 'set practicals' over the problem-based approach. The consistent response was that the laboratories were more enjoyable while at the same time giving students insight into 'real' analytical chemistry.

Full course design
Developing a full course based on project work posed additional challenges over those experienced in the pilot analytical chemistry course. The scope was broadened to include all areas of chemistry and the course is open to students having a wide range of chemistry backgrounds, the only prerequisite being completion of at least one other third year chemistry course. The aims were (a) to make problem-solving and team work central to the course and (b) to provide the opportunity for students to develop skills in planning and experimental design as well as written and oral communication. Students are given as much autonomy as possible in running the projects, while staff are available for support and advice at all stages from planning through to reporting. The course is a 14 week course during which students carry out two 7-week projects, one in synthetic chemistry and one in physical/analytical chemistry.

The structure of a 7-week project is shown in Table 1. The group size is typically 4 students, although groups of 3 and 5 have been used. Students are given some choice in selection of projects and groups usually rearrange for the second half of the course. Several class meetings are held during the planning stages, to ensure that students are aware of the various issues involved. These include clearly defining the goals of the project, proposing specific experiments, estimating the feasibility of these experiments and carrying out risk assessments. Students are responsible for 'ordering' chemicals in advance from the laboratory staff and booking access to shared instrumentation. Good communication between group members and clear allocation of responsibilities on a week-by-week basis is therefore essential if progress is to be made.

Timing	Activities	Comments
Week 1 – induction	Groups formed; projects allocated; literature review and planning	A project consultant is available to assist groups in planning and laboratory set-up
Week 2 – experimental plan	Groups present a written plan and initial risk assessment	Experimental work begins once the plan and safety aspects have been approved
Weeks 3-6 – experiments	Experimental work for the project (open laboratory format; 6 hours laboratory work per week per student)	A progress report is presented in week 4
Week 7 – project report	All work must be completed by week 7	A written project report and seminars are presented

Table 1. Structure of a project module

Student feedback

Overall students have given very positive feedback although some minor fine-tuning continues. The major issue of concern to students is the group-work aspect of the course and how it might influence their assessment. A briefing is held in advance to explain the course structure and since the course is an elective, students with major concerns in this regard can opt out. While the assessment is mainly based on group reports, some individual assessment of seminar presentations and laboratory notebooks is included. Peer group assessment has also been introduced, to enable groups to report on the contributions of their members to the work of the project. In order to improve team work operation, a more formal induction into group work is being included in the induction phase of the course.

Students are highly motivated by projects which have a well-defined context and the most popular projects are those where the outcomes have some practical significance. Synthetic chemistry projects are more difficult to design to suit the 7-week period and some further refinement in this area is being undertaken. Examples of projects are available on request from the author.

Conclusions

The course has successfully met its major aims. Overall the course has proved beneficial to students going on to an honours year but has been equally valuable to students moving into the workplace with a three year degree.

Acknowledgements

The support and enthusiasm of both academic and technical staff in Chemical Sciences at UNSW is acknowledged as essential to the running of this course. The contributions of students in CHEM3141 and CHEM3101 are also acknowledged.