

REINVENTING ORGANIC CHEMISTRY TEACHING LABORATORIES – Dr Jo Geden

Aim

To reinvent the role of Warwick Chemistry undergraduate teaching at Levels 1 and 2, with the aim of putting learning through practical experience at the front end of the undergraduate learning experience.

Objectives (set mid November 2005, to be achieved by mid April 2006)

- To rewrite the 1st and 2nd year organic practical course to make the experiments more enquiry or research based.
- To promote independent learning of new topics in organic chemistry.
- To deliver the revised 1st year course in January 2006, and evaluate its success.
- To prepare manuals for a revised 2nd year course ready for implementation in 2007.

Project Status (end January 2006)

- The 1st year organic practical course, which includes 6 compulsory experiments, has been rewritten.
- The revised 1st year course has been completed by over 150 students including both Chemistry and Biochemistry undergraduates and is currently being evaluated.
- Observation of the current 2nd year organic practical course has been undertaken.
- The process of rewriting the 2nd year course has begun.

Changes to the 1st year course (refer to 1995 and 1996 student manuals)

Evaluation of the previously taught 1st year organic practical course identified that:

- Students were told the outcome of an experiment before beginning the experiment, thereby removing the element of enquiry and intellectual challenge which is typical of research.
- Students explained their experimental results on the basis of the told outcome, and results were not used to deduce the outcome of a chemical reaction.
- It was possible to carry out the experiments with little understanding of the chemistry involved.
- Experimental procedures were given in great detail preventing students from working out for themselves the best way to tackle a practical problem.
- Some experiments had health and safety issues associated with them and these experiments needed to be completely replaced.

The revised course:

- Includes experiments which clearly define a problem (most often the evaluation of a reaction outcome) which needs to be solved during the practical session.
- Clearly sets out the learning objectives at the start of each experiment.
- Sets an assessed pre-lab assignment which ensures that students have read about the subject matter and practical techniques associated with an experiment before carrying out the experiment.
- Includes a pre-lab talk by the demonstrator to his or her students in the laboratory which is aimed to improve the interaction between the demonstrator and students during the experiment and thereby promote learning.
- Writes experimental procedures, where possible, in the same style as that found in academic journals preparing students for research.
- Asks challenging questions related to each experiment to see if students can apply what they have learnt to unfamiliar situations.
- Has a mark scheme where significant marks are awarded for solving the problem and carrying out extended reading, and marks are also awarded for practical skills and observation of safety rules.

Observation on revised 1st year course

- Students were heard to be commenting that they found the course interesting.
- Learning through group discussion about topics in organic chemistry was evident as problems were solved.
- Students preferred to work out the solution to a problem for themselves where possible before approaching a demonstrator.
- Students were not rushing to complete their experiments (as observed in previous years) and had the opportunity to reflect on what they were doing.
- Marks allocated to students for their write-ups show a good spread of marks between A (First) and F (Fail) indicating that the mark scheme has been successful in differentiating between students.
- As anticipated, those students who did not prepare for the session and did not read the references given achieved lower grades.

Student feedback on revised 1st year course

- Feedback has so far been obtained by the oral questioning of students by the Research Assistant during practical sessions, the return of 78 departmental feedback questionnaires, and by conversations with a student representative who attends departmental Staff Student Liaison Committee (SSLC) meetings. (The SSLC constitutes a formal channel through which the views of students on academic matters are communicated).
- General feeling is that students have enjoyed undertaking experiments where the outcome of a chemical reaction is unknown, and have found the experience “more interesting” than previously encountered practical courses which are more prescriptive in nature.
- Some students have found aspects of the course “difficult”, and this may be due to the fact that some of the theory required to solve the problems has not been taught in lectures and they are not yet used to independent learning.
- Those students who felt stretched by the course in the first week now feel that they have benefited from the course.
- The most popular experiment “Reaction of a tertiary alcohol with concentrated hydrochloric acid” was one which has been completely reinvented.
- Students have felt that the marking of their reports has not been consistent between demonstrators. (This is a surprising comment since a comprehensive mark scheme has been issued to demonstrators which give detailed instructions on how to mark reports).
- Feelings towards the revised course will be captured in focus groups which will include students who have repeated the year, and have experience of both the old and revised 1st year course, and also demonstrators which have taught both courses.

Proposed questions to ask students in focus groups:

- What was the most enjoyable aspect of the course?
- What was the most difficult aspect of the course?
- How does this course compare with the other practical courses you have undertaken at Warwick? Explain.
- How could the course be improved?
- What have you learnt about organic chemistry which you did not know before the course started?
- Does the course encourage you to undertake research in organic chemistry in the future? If not, why not?

Results of departmental feedback forms (78 forms returned):

	√√	√	?	X	XX
The aim of the experiment was clear. <i>I knew why I was doing the experiment.</i>	29	41	4	4	0
Instructions provided by carrying out the experiments were unclear. <i>I didn't know what I was supposed to be doing.</i>	2	7	9	38	22
Problems which arose could generally be resolved by consulting a demonstrator. <i>I found the demonstrators helpful.</i>	30	42	3	2	1
The feedback I received on experimental write-ups left me better prepared for subsequent experiments. <i>Comments in my lab book were helpful.</i>	5	27	9	21	16
The availability of laboratory equipment/kit was adequate. <i>I could usually find what I wanted.</i>	27	42	2	7	0
Problems with equipment failure regularly held up my progress during the course. <i>The equipment never worked.</i>	0	6	6	45	21
The laboratory sessions were not long enough to complete the required experiments. <i>I was short of time.</i>	1	1	2	25	49
There was excessive repetition of material from other lab courses. <i>I had done it all before.</i>	0	7	14	41	16
Given the subject material and the resources available, the course was entirely adequate. <i>I learnt something new from this course.</i>	22	50	3	3	0

√√ = strongly agree, √ = agree, ? = no comment, X = disagree, XX = strongly disagree

<i>Which was the best experiment?</i>	<i>Which experiment would you drop from the course?</i>
Tertiary alcohol – 13 votes	Separation – 14 votes
Bromination – 11 votes	Tertiary alcohol – 9 votes
Natural product extraction – 9 votes	Reduction – 8 votes
Functional group identification – 8 votes	Bromination – 7 votes
Separation – 7 votes	Natural product extraction – 6 votes
Reaction of natural product – 4 votes	Reaction of natural product – 3 votes

Recommended improvements for 1st year course

- Assign one demonstrator per group of students and do not rotate demonstrators. The rotation of demonstrators caused problems in the collation of total marks since different demonstrators marked the “pre-lab and lab” and “write-up” components of assessment. The benefit of rotating demonstrators was that demonstrators built up an expertise in a particular experiment, and students experienced a range of demonstrators.
- Minor changes required for the student manual and demonstrator’s guidebook have been identified and amendments will be made.
- It may be beneficial to include additional steps to some experiments to increase the time spent doing practical work. Some experiments finished well before the allocated time of 4 pm. Whilst some students stayed until 4 pm to solve the problems, many left the lab as soon as they had finished practical work. Introducing more practical work with such a large group of students may cause problems, however, without the investment of an additional infrared machine in each instrument room.

Appendix

1st year organic practical course 2005

Revised 1st year organic practical course 2006 – student manual.

Revised 1st year organic practical course 2006 – demonstrator’s handbook.

Sample student lab reports for revised 1st year organic practical course 2006.