Multimedia preparation for first year chemistry and physics laboratories

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Introduction

'Wet' labs are used because chemistry and physics are experimental sciences. It is vital that students experience real laboratory situations and techniques. It is also important that they learn to work through a whole experimental problem — from aim to conclusion. It is also important, in view of their future employment tasks, that they learn to conduct practical work safely: that they deal with potentially hazardous situations such as handling hot containers, pouring real acid, mopping up spills, and coping with broken glass. It is found that much learning occurs in the laboratory — students comment that a particular point was not understood until they met it "hands-on" in the laboratory.

'Wet' labs are high cost facilities. A large cost is incurred in staff time — academic (including co-ordinators and demonstrators) and technical support staff. The laboratory building itself is usually specialised and represents a large capital expenditure. Equipment, including balances, glassware, and instruments, is another cost and the cost of consumables and waste disposal, especially in a chemistry laboratory, is high.

The 'wet' labs are only available to students for a short time each week (typically 2-3 hours), so it is vital that students make best use of them. To do this, the student needs to come to the lab prepared.

Many approaches to laboratory pre-instruction have been tried. In the absence of any formal pre-instruction program, it is found some students do prepare thoroughly (by reading the laboratory manual) while others do not (to the extent of not even knowing which experiment is scheduled). Written exercises are frequently used for laboratory preparation. These may be done hurriedly and in consultation with other students. Demonstrators may give an introduction during the laboratory class, but these have been found to be of variable quality and quantity. In attempting to address these issues we have developed audio-visual based laboratory pre-instruction material — a set of videotapes (physics) and an interactive multimedia CD-ROM (chemistry).

One advantage of centrally prepared material is that it gives a uniform starting point for all students undertaking the laboratory. It also may be prepared by experienced teachers, whereas the laboratory staff is often of variable experience and quality (experienced academics; new academics; post-docs; PhD, Masters and Honours students).

Physics videos

Videos were considered to be an appropriate technology for delivery of the physics pre-lab material, as video players are widely available (in the laboratory, in the library, at home)

and most students are familiar with using videos. Unlike the laboratory manual, videos employ colour, sound and motion to give a more realistic presentation of the experimental methods and techniques. The video material produced also serves as a resource for future use, for example as digital video, on CD-ROM, or on the World-Wide Web.

Chemistry CD-ROMs

In chemistry, we have developed 'dry' labs pre-instruction using interactive multimedia, packaged on a CD ROM. These 'dry' labs provide practice in a safe environment by using simulated experiments and instruction in and demonstration of good techniques by video. The use of random data allows each student to do his or her "own" experiment. Successful completion of the 'dry' lab is necessary before lab entry.

It should be recognised that the time and cost in producing interactive multimedia materials are considerable. In our case, the design and production took 18 months. Many types of expertise are required: academic staff writing, materials, actors for video clips, camera persons, film editors, graphic artists, instructional designers, programmers, student reviewers (pre-cutting of CD), technical staff to prepare materials, voice-over persons for videos and simulations. An initial CAUT grant (Awarded 1992) of $39,000 covered some of the costs, but many additional costs were borne by the University: academic staff time, computer site expansion, computer supplement and upgrade, CD cutting-trial and final, evaluation and modifications, filming staff and filming materials, printing costs, software purchase, technical staff time. It is estimated that the total cost is about $100,000.

Evaluation of physics videos

Student surveys held in each of the first two years of the use of the videos yielded positive responses. Concerning production values, the videos were rated of appropriate length, good technical quality, relevant to the experiment, and helpful. The students thought the videos would increase their understanding of and performance in the experiment. As an overall appraisal, the students recommended the future use of the videos.

The performance of the student in an experiment in which s/he saw a video, relative to one in which s/he did not, was examined. The book mark, class mark and total mark were considered. The marks gained after viewing the videos were not statistically different to those gained without watching the videos.

Evaluation of chemistry CD-ROMs

Extensive evaluation of the CD-ROMs was undertaken, including an initial test/control trial, the completion of an evaluation instrument by each student for each pre-lab, observation of students in action, keeping a log book of problems, comparison of student performance on labs with and without interactive multimedia pre-labs, post-graduate student research, leading to enhanced awareness among Departmental staff of teaching /learning quality.

In response to an evaluation instrument, students indicated the CD-ROMs were easy to follow, adequate in covering all important points, good lab preparation, easy to understand, clear in explanation, user friendly, easy to get started, successful in making one confident about the lab, better than written pre-labs, better than demonstrator talk, easy to use, convenient to access.

Some comments from students are:

" I really feel I now know what to expect when I come to the lab"
"That was great — a wonderful use of modern technology"

"The CDs take a bit longer than the written pre-labs but are worth it!"
" We want more!"
"I am going to blow up the computer lab and destroy the CDs so no unsuspecting first years can ever use them and go through the mental strain. Many of my closest friends are now in therapy".

Comments from demonstrator:

"Group B asked more meaningful questions and generally seemed to have a better understanding of the experiment".
(Unknown to the demonstrator Group B was the group that had completed the CD pre-lab.)

Conclusion

The production of videos interactive multimedia materials is costly and time consuming, but can provide a quality teaching/learning tool that can be shared with other educators and institutions. The use of the CDs in particular requires availability of sufficient computing hardware, which many students have problems with.

Many students find the video and CD prelabs stimulating and feel better prepared and more confident after using them. Student scores on labs with video or CD prelabs are slightly better are not statistically significantly different to those without. However, the measures used to test for effects may not be sensitive to the changes. Finally, our aim has not been to replace the traditional 'wet' lab, but to facilitate our students making the best use of it.

Further Reading

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