Thermal Physics Resources on the Web

Pal Fekete and Brian McInnes
Sydney University Physics Education Research Group (SUPER)
School of Physics, The University of Sydney
and Paul Walker, University College London
fekete@physics.usyd.edu.au

Introduction

In 1995 Dr Fekete was employed by McInnes and Walker as part of a CAUT project, "Diagnostic Tools for Concept Development", to develop a practical and accessible database of resources that would encourage deep learning through interactive teaching in large class environments to be used in a first year lecture course on Thermal Physics. The web was chosen (http://www.physics.usyd.edu.au/teach/thermal.html) as the preferred choice of delivery as it was the most suitable medium to disseminate information to a large international body of academics. The material was specifically designed for large lecture theatre environments and included:

- information on how to use demonstrations interactively;
- a bank of questions designed to promote deeper conceptual understanding;
- references to research literature; and
- information on CD, video and film resources.

A previous discussion of this work and the database can be found in an earlier UniServe Science article "Interactive Teaching Resources for Thermal Physics Available on the Web", UniServe Science News, Vol. 8, November 1997.

Background

Both the lecture resources developed and the medium chosen to disseminate them were intended to be interactive in nature. Academics are able to choose demonstrations and other resources which complement their teaching styles and through these resources are also exposed to alternative approaches in teaching, in particular interactive teaching. If used by lecturers these resources encourage students to develop deep approaches to learning, rather than the common "surface" approaches of trying to remember facts, formulae and mathematical techniques. Students are able to identify relationships between physics and the real world and become more confident in the use of words as well as equations and algebra to describe the phenomena they observe.

Interactivity in demonstrations is encouraged through the Predict, Observe, Explain (POE) (Liew and Teagust, 1995) process where students are first presented with a demonstration and asked to make a prediction. They are then shown the experiment which if well constructed will show a contradiction to their prediction. They are then asked to explain any discrepancies between their initial prediction and observation. The questions are also worded to encourage students to contemplate and explain their predictions.

Evaluation of Teacher Resources

Evaluation of the resources was carried out through a number of means. Approximately 10 students from each of the three normal classes were interviewed both before and after the course was taught; entry and exit quizzes were administered to all students of all classes at the start and finish of the

course; student appraisal and attendance was recorded; exam performance was evaluated. From this analysis we were able to show:

- students were better able to identify relationships between physics and the real world and showed greater conceptual understanding (interview and quizzes);
- student questionnaire responses indicated that the lectures were enjoyable, stimulating, satisfying, challenging, productive and thought-provoking; sustained student attendance throughout the course supported this judgement;
- the interactive style of teaching was popular with the students compared to the traditional teaching styles (course rating 4.0 out of 5.0 (best) compared to 3.5 and 3.3 for two parallel streams);
- preliminary student performance on traditional examination questions was equivalent to previous years;
- analysis of some of the quiz questions showed that conceptual understanding of students exposed to interactive teaching improved by as much as 30%;
- anecdotal evidence indicated that some students adopted deeper learning approaches; and
- despite my overzealous attempt to get the students to participate in lectures and take control of their learning participation was still less than about 30% of the time spend in the lecture theatre.

The database has already been shown to be useful to teachers both at our own university and other universities in Australia and abroad. Several people and places outside The University of Sydney have used the resources, however in general they are not well patronised. It is believed that the main reason for this is that lecturers are too busy to spend time exploring new resources. As a result of the poor patronage by academics it has been decided to develop these resources to become student centered.

Student Centered Resources

It is intended that these resources will be developed so that the ownership of learning is on the student. The web will be used to deliver content and to develop some conceptual understanding in students. This will free up lectures for reinforcement of concepts, development of more difficult concepts and problem solving, i.e. deeper learning.

Our current lecture course in Thermal Physics (TP1) is taught in second semester of each year to first year students and consists of 12 one hour lectures and 4 one hour tutorials spread over four weeks. In this course students get lecture notes in terms of *PowerPoint* handouts printed six per page. Two assignments are given with a formal exam at the end of the semester covering material from TP1 and two other courses.

The facility for students to access the material themselves, the newsgroup for communication, will aid this process. The use of the web will also assist by improving feedback about student preparedness, the effectiveness of teaching and ongoing course development. This should result in better performance by students in qualitative physics and an improvement in their understanding of fundamental concepts.

Conclusion

During 1995 and 1996 a database of teaching resources was developed on the web, which includes information on how to use demonstrations interactively and probing questions which are suitable for use in a lecture course on Thermal Physics. The original database was intended for use by academics

when preparing lecture courses and tutorials, and was documented in a way to encourage academics to develop deep learning strategies in their courses. This resource has been demonstrated to be useful to academics when teaching Thermal Physics and popular with students, however it has not been well patronised by academics.

In order to combat this Fekete is now extending this resource for use by undergraduate students. Students will be able to access the resource for themselves and also communicate to each other and the lecturer via the web. Various approaches to enhancing the web site for student use have been described.

Ultimately we may use the resource for distance based learning. We are also exploring using *NetMeeting*, a computer meeting environment with voice, whiteboard and other forms of communication. In the future it may be possible to reduce face to face contact allowing more time for problems and discussion in tutorials.

Reference

Liew, M.C.W. and Treagust, D.F. (1995). A predict-Observe-Explain teaching sequence for learning about students' understanding of heat and expansion of liquids, *Aust. Sci. Teachers J.*, **41** (1).