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Designing a Web-based learning environment to maximise interactivity

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Abstract

The on-line learning support system for first-year physics students described in this paper gives students enrolled in an on-campus traditional course an alternative learning strategy for two-week modules of their course. This paper presents some of the decisions and choices made in designing such an on-line learning resource and examines the role of interactivity. In this presentation, some examples from the materials produced will be shown.

Introduction

One of the challenges in university education today is to provide students with meaningful on-line resources either to support their lecture-based courses, or to replace them. One of the dangers is to finish up with a virtual electronic textbook which provides very few of the advantages that information technology offers. Physics educators face other specific challenges. To them, physics is an exciting discipline relating conceptual understanding to real-world events. However, this is often not the view held by students! Students often have difficulty relating the physics they learn in class to the real world outside (McDermott,1991). They do not link learning to experience. In addition, they are forced to confront many conceptual difficulties and often find lectures too passive to challenge these misconceptions.

This paper describes a project in which the development of highly interactive on-line learning resources enabled students to construct actively their understanding of important physics concepts. The traditional course comprised three lectures, one 3-hour laboratory session and one tutorial (dissertation) each week. This project focussed on replacing the least interactive component of this learning program, the lectures. On-line materials with a heavy emphasis on interactivity and engagement replaced all but the first and last lecture in the 2-week period. These two lectures were used to introduce the learning materials and expose students to key demonstrations and to summarise interactively the units studied.

Design rationale

Our aim was to develop Web-based learning resources that would provide direction to students' learning and improve their learning through the highly interactive nature of the tasks. Students used these resources in scheduled classes with a teaching assistant present to help with technical and conceptual questions. They also had free access at times of their own choosing from other university computers or from home. In addition, students were engaged in collaborative interactive tasks in their weekly laboratory classes and tutorials.

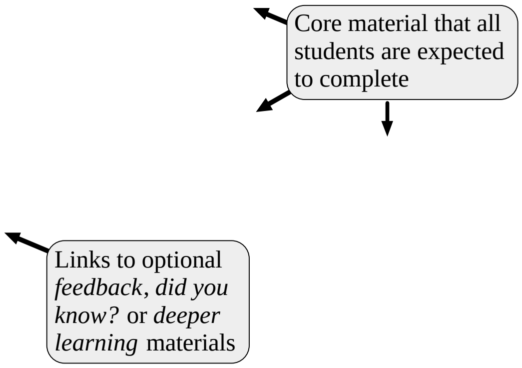
Deep learning takes time!

In designing the suite of interactive tasks for the package, it became apparent that material described in a short section of a textbook, or "covered" by a lecturer in five minutes, could easily demand 30 or 40 minutes when constructed as an interactive learning activity. The difference is the time taken for students to focus their minds on the concepts, make predictions, observe and reflect outcomes. That is, to engage in a truly active learning session. Clearly, four hours of lecture material would easily expand into much more time than most students would be prepared to commit to the task.

Our solution to this problem was to define a minimum "core" of material that every student would be expected to work through. Student are also presented with optional links in the margins to several different types of material (see figure below):

"Feedback" – responses to questions posed to students
"Did you know?" – information to embellish the core
"Deeper learning" – in-depth learning activities designed to promote deep learning.

It is the last of these three link types that allows students to choose to embark on an activity that might take them 15 or 20 minutes, whereas those who feel



Core material that all students are expected to complete

Links to optional *feedback, did you know?* or *deeper learning* materials comfortable with the core material might choose to skip this extension. In this way students choose for themselves to take on activities that require more time from them, but will promote better, more robust learning.

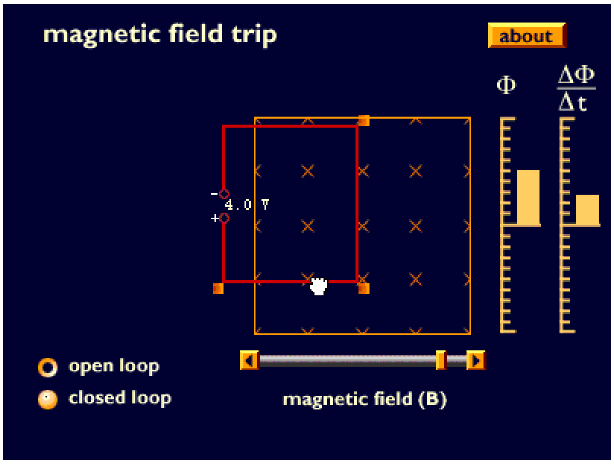
Interactivity

“Interactivity” has been defined by Laurillard (1993) as “students receiving intrinsic feedback on their actions that relate to the goal of the task”. Our interpretation of this was to ensure that every screen is an activity; that students have to do something every time they move from one screen to another. These activities usually require students to make a prediction, use the computer to observe an outcome, then reflect on and explain what happened, or what they observed.

Each activity provides the students with feedback. This can be “explicit”, where students are provided with a model answer, or “implicit” in which students check their reasoning by interacting with an animation or simulation.

The styles of interactions used vary in their complexity. At the least sophisticated end of the spectrum, students are required to observe an on-screen event (animation, video or sequence of images), record their observations and explain them to each other or in writing. A second type of task requires them to make a prediction of the outcome of an event, observe what actually happens (animation, video or simulation) and again explain it. Having students commit to a prediction, reflect and then resolve any conflicts that arise between their prediction and subsequent observation, is an extremely valuable task in changing students conceptions. The value of this learning strategy as applied to a lab-based course is described by Laws (1991).

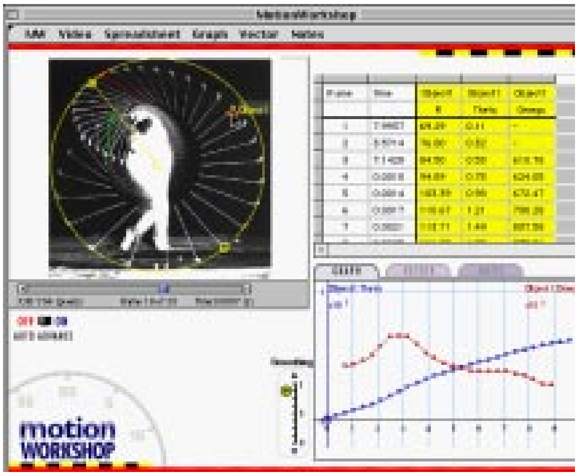
In other tasks students are lead through a guided discovery sequence to present a concept. An example of a component used in these tasks is the on-line simulation *Magnetic Field Trip*. This simulation is used to develop students’ understanding of how several variables affect the generation of an induced voltage in a wire loop as it enters a magnetic field. The figure in the next column shows the loop being dragged into a magnetic field (area of crosses). Two bar displays, changing in real time, are used to indicate the magnetic flux and the rate of change of flux, respectively. It is the fact that the induced voltage depends on the *rate of change* of a quantity that makes this concept hard to grasp. *Magnetic Field Trip* allows students to explore several parameters that affect the induced voltage (loop speed, direction, position, size, and field strength). This simulation is used in the “core” section of the materials as an interactive illustration of the ideas of magnetic flux. In addition, students can choose to follow a “deeper learning” activity that uses the simulation in a more extensive structured learning activity.



A more sophisticated example of interactive engagement employs an on-line video-analysis tool, *MotionWorkshop* (Pearce & Livett, 1997), also designed by the authors. This allows students to analyse a motion presented in a video-clip by clicking frame-by-frame on the object and seeing the (x,y) co-ordinates of the object recorded into a spreadsheet table. Graphs can then be plotted on-line and manipulated in real time. The same spreadsheet table can be used to enter formulas representing mathematical models of the motion so that the model can be directly compared with real data. *MotionWorkshop* can be used to analyze videos or multiflash photos of a range of motions, for example, sprinter starting a race, clubs being juggled, hammer being thrown, etc.

The figure on the next page shows a screen shot from *MotionWorkshop*. Here, a multi-flash photo of a golfer has been analysed (photo by Harold Edgerton, with permission). The picture at the top left of the screen shows the golf club at different positions during the swing; a polar co-ordinate system has been drawn around the centre of the picture. The top right shows the spreadsheet table where the times are displayed, together with the radial position data (R), angular position (Theta) and angular velocity (Omega). These latter two quantities are also displayed on the graph. Each of these three representations of the data remain hot-linked.

A student task using *MotionWorkshop* would typically involve making predictions about the outcome of their analysis. For example, in the case of the golfer, where is the angular velocity increasing? Where is it decreasing? Where does it have its maximum value? Again, student commitment to prediction, prior to analysis, and subsequent reflection, reinforces the value of that analysis in developing their thinking.



Student response

The focus group of students that was interviewed gave very positive feedback on this style of learning resource. Students showed an awareness that having more control over their learning increased its effectiveness.

They commented on the value of describing, in their own words, the video-clips and that spending extra time using the animations and simulations was valuable. They stated that the extra time required to do this was not a deterrent to them. It was preferable to spending time trying to derive the same understanding from a text book or lecture notes because this was a more active process. A more extensive evaluation is planned for later in 1999.

Issues

Several important issues were confronted and resolved during the design of these materials. Two in particular stand out as being worthy of special note.

The first, the time required to produce such materials, will come as no surprise to anyone who has had involvement in similar development projects. As a very rough estimate, a learning module requiring about 6 hours of students' on-line time demanded from an academic: about 30 hours of planning; 90 hours researching, designing and developing content; 60 hours producing multimedia elements (animations, QuickTime movies); and 10 hours briefing multimedia professionals. An additional 50 hours was spent by a graphics designer, and 80 hours by a programmer developing one on-line simulation (*Magnetic Field Trip*).

The second issue relates to who does what. "Learning design" is the crucial and most difficult aspect of such a project. It is far more important than the technology or the software, and applies just as importantly to a page of static text as it does to a simulation. Unfortunately this is the expertise that cannot be out-sourced easily. It is time consuming and it is our experience that it requires an academic with a strong understanding of the relevant discipline together with an interest and expertise in education and multimedia techniques. That is a rare combination to find.

In this project, of the 190 hours put in by the academics, only about 60 hours could have been out-sourced to a non-academic developer. The concluding message here is that for learning projects such as these to be effective, they need a major commitment from faculty academics and strong support from their department's administration, especially if such activities distract from academics' research output.

Conclusion

The production of on-line information systems that promote deep learning in students can be done in a way that students find enjoyable and effective. However, the time commitment is great on the academics' part and requires positive encouragement and support from the host faculty.

Technologies and acknowledgements

This project was funded by the University of Melbourne; the Department of Employment, Education, Training and Youth Affairs; and Apple Computer (Australia). The simulation *Magnetic Field Trip* was produced in Macromedia Director and presented as a Shockwave object. *MotionWorkshop* was written in Java, making use of Apple Computer's QuickTime for Java. We greatly value the programming expertise of Duc Do Minh (*MotionWorkshop*) and Daniel Robertson (*Magnetic Field Trip*).

References

Laurillard, D. *Rethinking University Teaching.* London, Routledge, p. 94, 1993.

Laws, P. W. "Millikan Lecture 1996: Promoting Active Learning Based on Physics Education Research in Introductory Physics Courses". *Am. J. Phys.*, Vol 65, No. 1, p. 14, 1997.

McDermott, L. C. "Millikan Lecture 1990: What we teach and what is learned—closing the gap". *Am J Phys*, Vol. 59, No. 4, p. 301, 1991.

Pearce, J. M. and Livett, M. K. "Real-World Physics: a Java-based Web Environment for the Study of Physics", *Proceedings of AusWeb97*, A. Ellis and R. Debreceny (eds), Gold Coast, July 1997.