Paper presented at the Open and Distance Learning Association of Australia Forum - 1999. Geelong, Australia

Strategies for cost effective development of educationally powerful web materials: interactive learning objects within a HTML framework

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27 -30 September, 1999.

We want educational interactive multimedia (IMM), whether it be delivered over the web, CDROM or via another mechanism (e.g. webTV) to have wide application and to enhance educational work. This will only happen if the IMM materials which we develop achieve the following two goals:

- the IMM materials can be developed in a reasonably cost effective way; and
- the IMM materials allow more powerful educational interactions compared to other methods.

While many approach these goals as if they are mutually exclusive, our experience suggests that the use of cost effective development strategies can actually enhance the educational "potency" of the product. One of the most obvious ways in which this occurs is that if development is more effective then we are able to implement more of the unit or make a higher quality implementation. Often we hear people proudly telling others how they are delivering their units via CDROM or the web and when questioned it is sobering to hear that students only use the CDROM for one week out of a 13 week unit.

This paper describes some of the methods the Interactive Multimedia group at USQ is using to reduce development costs while increasing the educational power of IMM materials. This paper does not attempt to quantify "educational power" other than to say that it can be judged based on feedback from students and teachers and that certain features are associated with more powerful materials (e.g. higher levels of flexibility and access, information richness, learner control, interactivity etc).

The Interactive Multimedia (IMM) group (USQ: IMM. 1999) is a small (5 staff) group of interactive multimedia developers working within a team of media and educational specialists in a Distance Education Centre. More information is available at the IMM group web site. The majority of our work is used within USQ units but we also do commercial work for non-USQ clients.

DEVELOPMENT PRINCIPLES

It is critical to have some strategic guidelines and general development principles in the field of interactive multimedia development. Without general guidelines it is possible to be continually buffeted by ever more turbulent technological developments.

Below are some general principles that have thus far served us well.

Structure the content independent of the delivery platform

The delivery platform (whether it be a CD-ROM or a web site) is not as important as the organisation of the content and the teaching learning activities woven into the unit. For this reason it is critical to keep the content independent of the CDROM thus allowing future versions of the materials to be developed.

Use of structured markup languages by content experts

In addition to allowing the content to be maintained independent of the delivery platform the use of a markup language allows the content expert to retain joint authorship of the content throughout the developmental period. Most content experts want to be involved with all aspects of the project and don't want to deliver the content to the IMM group and only return 3 months later to a completed project (often not the one they wanted). Creating highly interactive environments is very difficult if we are using "batch" orientated production models which are more suited to the production of non-interactive media e.g. books.

Many of the tools we have created allow the content expert to be actively involved throughout the production process. For example, the interactive label or the referencing tool allows the lecturer to create an activity, save it, and then immediately look at the finished object within a web browser.

"Hot" and "cold" media and development methods

McLuhan (1964) introduced the concept of "hot" and "cold" media to signify the representational richness and the "amount of work" the user has to do when using different media formats. For example, a novel would be "cold" while a movie adaptation of the same novel would be "hot". Generally, but not always, it is more expensive to develop a "hotter" representation of some given content.

Many believe the use of a "hotter" media format will be automatically more effective than a "colder" format. We all know people, affectionately known as "technolusters", who want to use the very latest technology simply because it is available. "If 10 frames per second video is good then 20 frames per second will surely be better!" This is a very "technology focused" view of learning. In fact sometimes the use of higher quality media may even distract the user from aspects of the educational interaction. Craik and Lockhart (1972) suggest that a slightly degraded (or "cooler") message will result in higher retention levels.

How do we decide what representation to use? Sometimes the higher fidelity representation is warranted and perhaps even necessary to represent some given content to a given audience of people. For example, it would be hard to imagine novice musicians understanding a piece of music without hearing it (hot) while a musical score (cooler) may be adequate for more experienced musicians. We should carefully match the "heat" of the presentation with the educational goals, as well as features of the user and the content. For example, it may be possible to use a text based system for introducing an activity and the objectives but require full motion video to show the example and then revert to a text based system for eliciting feedback from the student.

The Hypertext Markup Language (HTML) provides a very cost effective development and delivery framework for presenting text, sound, images and video information (cooler) to the user. In addition it provides a flexible framework for embedding highly interactive learning objects (hotter)

HTML navigation and presentation framework

The phenomenal penetration of the web into work, education and play is due to many of the advantages which is presents. Below are some of the major advantages which HTML and the web offer:

- is an open standard allowing us to encode our content in a way which can be translated into a number of other formats in the future.
- can be produced relatively quickly and cheaply by academics using appropriate web publishing tools and methodologies (ILS-ML);
- can be delivered via several different delivery technologies (Internet, CDROM or even floppy disk) to a wide variety of different computers (Windows, Mac, UNIX etc)
- allows students to work within an increasingly familiar web based environment;
- can be extended by the use of other Internet technologies (e.g. email, other web sites, newsgroups); and
- the browser provides a wealth of functionality which our projects can utilise e.g. navigation, history and making and using bookmarks; and
- allows the use of plugins to enable additional functionality.

Perhaps the most significant weakness of pure HTML for our purposes is that it provides limited opportunities for highly interactive applications.

Embedded interactive objects

Java and the pluggin architecture of the web browser and the Internet provide a perfect environment for the use of small interactive learning objects. Perhaps the best known example of these are those created by the Educational Object Economy (EOE, 1999) and the Instructional Management System (EDUCAUSE: IMS, 1999) initiative sponsored by EDUCAUSE.

At USQ these learning objects have been branded Creative Opportunities for Online Learning (COOL) Tools. Most COOL Tools (CTs) are implemented in Macromedia ShockWave but JavaScript and Java are also used. These CTs allows us to include higher levels of interaction within the HTML presentation in a way that is both cost effective to develop and maintain. The COOL Tools support site (USQ: COOL Tools, 1999) provides more information.

Synergy

This two level development strategy of placing most of the content in a HTML based navigation and presentation level which contains highly interactive CTs has worked very well. It is possible to place any piece of content in either mode but carefully selecting the mode of each results in each synergisticaly leveraging the advantages of the other (see table 1). Additionally the weaknesses of each are complemented by the strengths of the other.

Table 1: Summary of the features of the two level development strategy.

	HTML framework (cooler)	**COOL Tools (hotter)**
amount of content	as much of the content as possible	only what is required to add educational power
development cost	lower	higher
delivery requirements	lower	higher (e.g. may require the user to download a plugin
unique strengths	provides the navigational and the presentation framework	high levels of interaction to solve specific educational problems
developed by	IMM group, USQ or any other organisation	IMM group

The next section of this paper examines the implementation of these ideas within projects we are working on.

THE HTML NAVIGATION AND PRESENTATION LEVEL

Currently most of the large web sites have been created using the Interactive Learning Services Markup Language (ILS-ML). ILS-ML is an Extensible Markup Language (XML) (XML.COM, 1999) compliant markup language which allows the content expert to quickly markup content in a way best suited their own project. These tags can easily be created "on the fly" in consultation with the content expert and because most academics are familiar with Microsoft Word we are currently using Microsoft Word to create the ILSML tagged documents. ILS-ML tags are also inserted into documents prepared by the desk-top publishing operators within USQ.

ILS-ML tags have been created that allow the insertion of CTs, the creation of indexes and tables of contents and the efficient formatting of web sites. An important feature is that these sites have several features which help prevent the user from becoming disorientated or "lost in hyperspace" (Conklin, 1987)

The web sites for the Master of Midwifery (Evans, McDonald, Fahy, 1999; Fahy, 1999) have all been created by midwifery educators using the ILS-ML web publishing system as has the Online version of the USQ Handbook (USQ: 1999 Handbook 1999).

COOL TOOLS

As already mentioned CTs are small interactive objects that are embedded into HTML pages. CTs have the following functional architecture (see figure 1):

- are designed to address a specific educational need and have a limited functionality;

- there is a separation between functions and data with the data stored in a supporting text file which is structured using XML compliant tags;
- the text file can be easily modified allowing the CT to be easily reused with other content and in other situations;
- the content expert can easily create the data text file either through the use of a custom built editor or a word processor;
- if required the CT can save data to the local hard disk allowing a student to return to a partially completed exercise over a several month period;
- the CT can interact with the following objects in its environment, the browser, JavaScript, other web pages (HTTP), email, web servers (CGI), other CTs etc

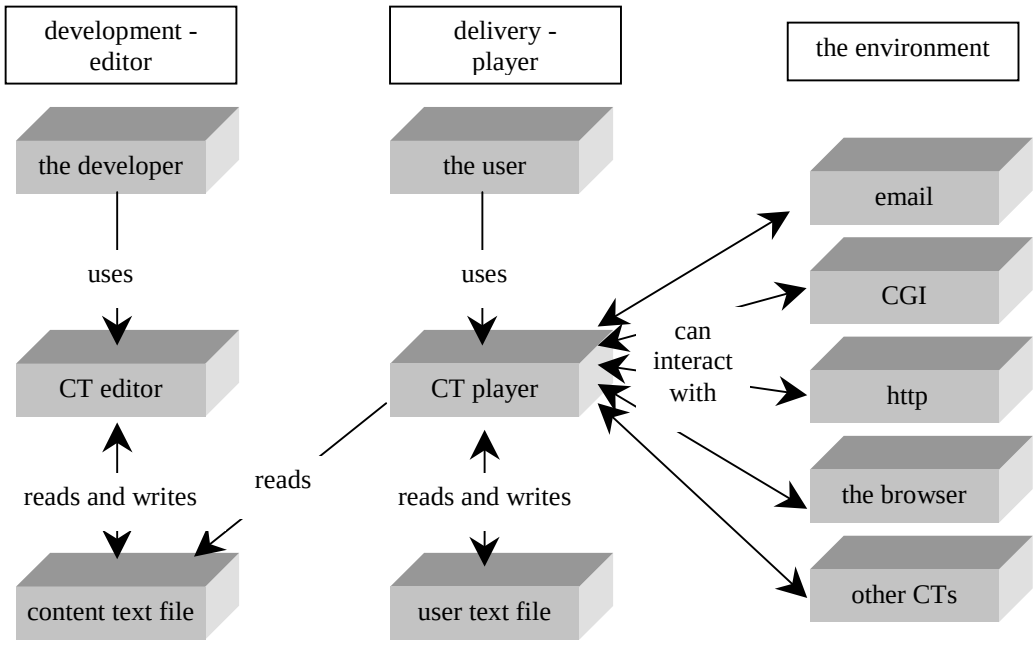

Figure 1: COOL Tool functional architecture showing the development and delivery environments.

It is no accident that functions which exist for the developer are closely matched by those available to the user. If a certain function is useful to the developer, then it is likely that the same function would also be useful to the student.

Example COOL Tools

Thus far eight CTs have been developed to do a number of functions (USQ: COOL Tools, 1999). There would be at least 400 different applications of these throughout units offered via USQ Online (USQ: USQconnect, 1999), USQconnect (USQ: USQconnect, 1999) and on various CD-ROMs. One such series of CD-ROMs is being demonstrated at this conference (Evans, McDonald, & Fahy, 1999)

Interactive Labels

The interactive labels CT (see figure 2) presents the student with a "control panel" which allows them to do the following with the labels on a diagram:

- show all the labels;
- hide all the labels;
- show or hide the labelled regions;
- hide the labels and show each label as the mouse is moved over it; and
- do a "self test" in which the labels must be dragged from the bottom of the screen to the correct location (if the location is not correct the label will fall back to the bottom of the screen.

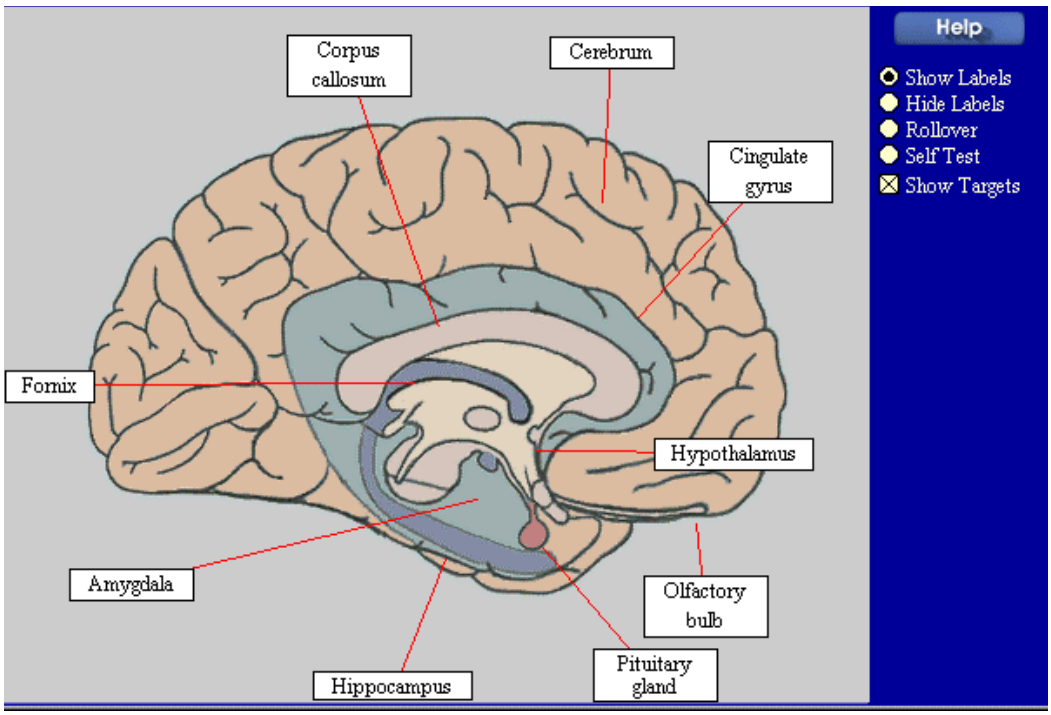

Figure 2: The Interactive Lables COOL Tool showing the label control panel.

The educational power of this CT is that it allows the students to interact with labelled diagrams in a way not possible with paper. Often this is used to learn basic naming and identification knowledge in a learner control environment providing immediate feedback.

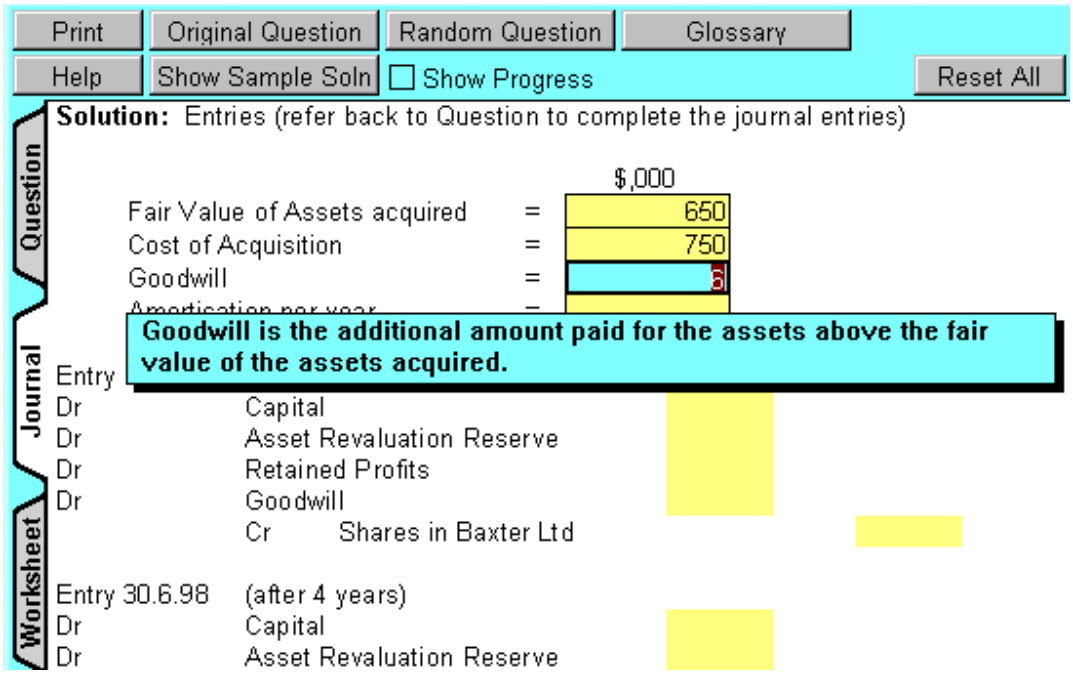

Figure 3: The Interactive Numeric Exercises CT showing blank fields for student to complete and some feedback on an incorrect answer. Some fields have already been completed.

The Interactive Labels CT is accompanied by an editor environment which the lecturer can use on their own desktop computer (Windows or Macintosh) to create such interactive labels. This editor presents a user friendly direct manipulation drag and drop environment allowing the lecturer to load an image to label, create labels, regions, and the exemplar point. The data for a functioning interactive label exercise can be created reasonable quickly and it can be immediately proofed within a web browser.

Traditionally, to label an image the lecturer would mark lables on a print out of the diagram, a graphic artist would then make the labels and the lecturer would proof these. Because of the exact nature of the labels (both their position and spelling) this process sometimes takes several weeks especially in fields such as physiology or engineering.

Interactive Numeric Exercises

The Interactive Numeric Exercises CT allows the creation of interactive exercise in any subject domain which requires the user to follow a set algorithm to solve a numeric problem. Figure 3 shows an example from accounting in which a question is presented and the user is asked to complete a worksheet and a journal which may contain any number of gaps. If the provided answer is correct the student moves to the next "gap" but if it is wrong a series of more directive hints is given until the answer is finally supplied.

The primary strength of this CT is that it allows a student to progress at their own pace through a complex and often long procedure. Instead of being overwhelmed by the process of doing the exercise and only getting feedback at the end the student will get immediate feedback guiding them to successful completion of the activity.

Media Synchronisation

Figure 4: Media synchronisation COOL Tool showing a video and a synchronised text field which the student can edit and save.

The Media Synchronisation CT (see figure 4) allows video or audio with accompanying image to be seemlessly integrated into educational materials. The heart of this CT is an indexing mechanism which allows a text field to be synchronised with a video or an audio track allowing you to:

- jump directory to any part of the video clip;
- annotate the movie with your own text which may contain links to other HTML page or even to another movie; and
- allow your students to analyse a section of video over several weeks and even submit this analysis in an assignment.

A common way in which this CT has been used is to guide a student through a sequence of steps in which they:

- preview a video without any options to stop or rewind it;
- analyse the video by playing it and making notes in the synchronised text window; and then
- view an expert's analysis of the video with links to supporting information.

Such an activity may occur over many months because the partial analyses are stored on the user's computer allowing them to add to their work completed in the previous session.

Text and Graphic Rearranger

These CTs are based on the idea of moving objects (graphics or text) around the screen, e.g. rearranging chairs, tables and computers in a classroom. The text version allows the user to drag text objects around the screen and one application (see figure 5) has been to prepare an interactive bibliographic referencing exercise. As the user builds up the bibliographic reference by dragging elements they receive immediate feedback.

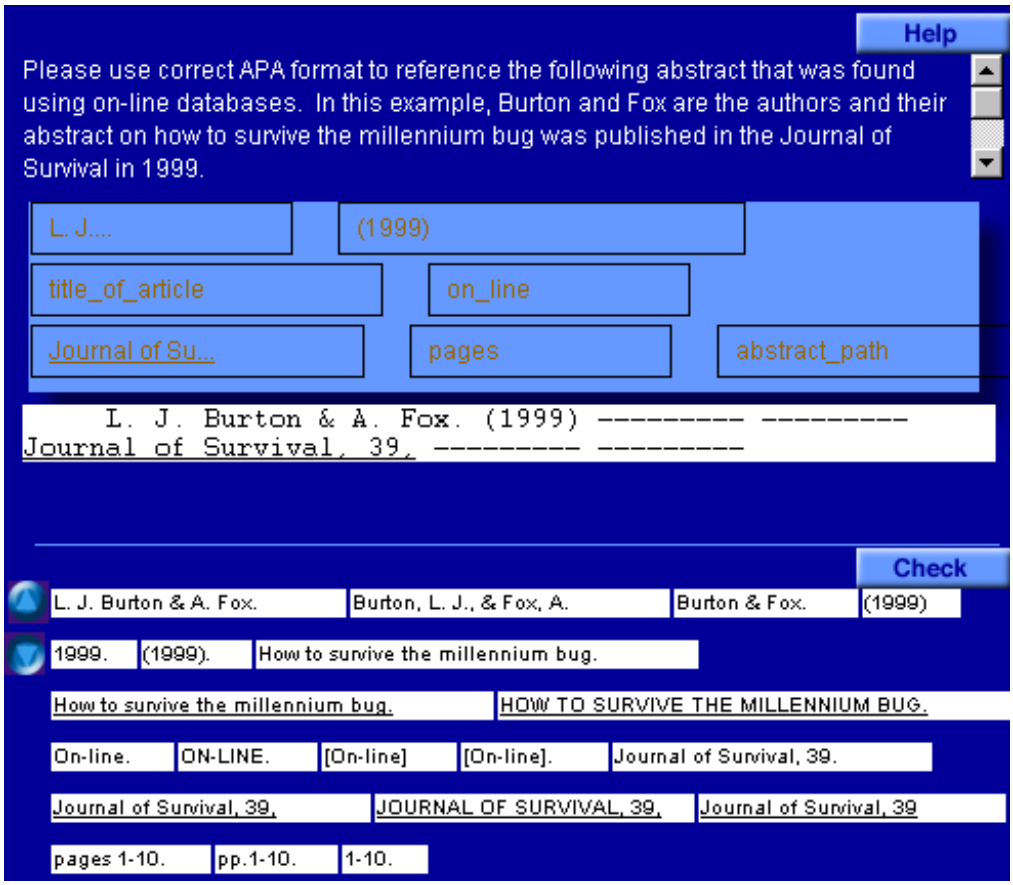

Figure 5: APA Text Rearranger giving immediate feedback as the student constructs a correctly formatted APA bibliographic reference.

The Text Rearranger CT uses text files which are easily prepared using either a JavaScript based editor or by editing the file in a word processor. It is likely that this CT will be used to allow students to practise many different styles of referencing.

PROJECTS

This section points to two recent projects which we have developed using these methods.

Four Master of Midwifery units

Four Master of Midwifery units have been delivered totally on CD-ROM (apart from some selected readings). While these units contain a vast amount of information and many CTs the speed of development has been quite

high. Aspects which have allows this to occur are that the majority of the content has been input and edited by the academics using ILS-ML and there has been significant reuse of CTs.

These units have been fully described in another paper at this conference (Evans, McDonald, & Fahy 1999)

The USQ online handbook

The web version of the USQ Handbook (USQ: 1999 Handbook, 1999) contains over 1600 pages of information interlinked by well over 30000 links. In addition to providing better access to the information compared to the print based handbook, the online version contains links to up to date information about staff, courses and units and other aspects of the university. In contract many university handbooks offer little more, and sometimes a lot less, than the equivalent print based document.

Both the print and the online versions of the Handbook were produced from a single Microsoft Word document containing embedded ILS-ML tags.

CONCLUSION

There is not necessarily a direct one-to-one relationship between development cost and the quality of an educational multimedia package. One strategy which we have found to be successful for reducing development costs and increasing educational effectiveness has been the use of:

- a HTML presentation and navigation layer which contains
- highly interactive learning object COOL Tools.

The HTML layer contains the majority of content within the unit and can be prepared relatively quickly by academics or others using appropriate web publishing tools. The CT components are designed to address specific educational problems requiring functionality not available through pure HTML.

ACKNOWLEDGEMENTS

I would like to acknowledge the collaborative contributions of the following people to the implementation of the ideas in this paper:

- instructional designers and media specialists within the Distance Education Centre;
- content experts and lecturers within USQ; and
- multimedia developers working in the IMM group.

REFERENCES

Conklin, J. (1987). Hypertext: An introduction and survey. *IEEE Computer, 20*(9), 17-41.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-684.

Daniel, J.S. (1990) 'Distance Education and Development', *Developing Distance Education*, vol. II, no. 3.

EDUCAUSE: IMS. (1999). *IMS: Instructional Management System*. Available: http://www.imsproject.org [accessed 1999, June 30].

EOE. (1999). *EOE: A Global Community for Web Based Learning Tools in Java*. Available: http://www.eoe.org/ [accessed 1999, June 30].

Evans, P., McDonald, J., & Fahy, K. (1999, September 27 - 30). *Flexible Delivery Provides Situated Learning in a Pre-registration Midwifery Course.* Paper presented at the Open and Distance Learning Association of Australia Forum 1999: The Challenges of the New Millennium, Geelong.

Fahy, K. (1999). *Master of Midwifery Units: 67571, 67573, 67574, 67575*. University of Southern Queensland. Available: CDROM but a sample is available from http://www.usq.edu.au/material/course/ta20/ [Accessed 1999, 29 June].

McLuhan, M. (1964). *Understanding Media: the Extensions of Man*. New York: McGraw-Hill.

USQ: 1999 Handbook. (1999). *1999 USQ Handbook*. The University of Southern Queensland. Available: http://www.usq.edu.au/handbook/ [1999, 28 June].

USQ: COOL Tools. (1999). *Creative Opportunities for Online Learning*. The University of Southern Queensland. Available: http://www.usq.edu.au/dec/ils/imm/cooltools/ [Accessed 1999, 29 June].

USQ: IMM. (1999). *Interactive Multimedia group*. The University of Southern Queensland. Available: http://www.usq.edu.au/dec/ils/imm/ [Accessed 1999, 29 June].

USQ: USQ Online. (1999). *USQ Online*. The University of Southern Queensland. Available: http://www.usqonline.com.au/ [accessed 1999, 30 June].

USQ: USQconnect. (1999). *USQconnect: USQ's student intranet*. The University of Southern Queensland. Available: http://www.usq.edu.au/usqconnect [1999, 25th May].

XML.COM. (1999). *XML.COM: Open Source Tools for XML*. Seybold Publications and O'Reilly & Associates. Available: http://www.xml.com/ [accessed 1999, June 30].