

COOL Tools: embedding highly reusable interactive objects within a HTML presentation and navigation framework

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Abstract

The Interactive Multimedia (IMM) development group at USQ has developed several strategies to facilitate the cost-effective development of powerful IMM components in a highly fluid and resource scarce environment. One such strategy is the development and use of small, highly reusable learning objects called COOL Tools (CTs). These CTs may be embedded in HTML pages delivered via the Internet or CDROM or delivered as standalone components.

Most CTs comprise a delivery engine and a "content" data file containing content information for that occurrence of the CT. For example, the content data file for the interactive labels CT contains the name of the graphic and for each label the text, position and region. This separation of the engine and content data file allows the same CT to be easily used many times (over 500 times in one case) with different content. This reuse reduces the per use cost to develop the CT as well as encourages use across disciplines.

In addition to being a highly cost effective development strategy, CTs also empower the content expert by providing them with fingertip control over their content throughout the development process. In many cases an editor allows the lecturer to directly create this content data file on their own desktop computer. The lecturer can also interactively develop and proof the CT by editing the content data file and then reloading the HTML page to see the new content.

This paper examines the design, development, and use of several CTs and concludes with current issues and future plans.

Context

The Interactive Multimedia (IMM) group is a small (5 staff) group of expert multimedia developers working within a team of media and educational specialists in the Distance Education Centre at the University of Southern Queensland. The majority of our work is used within USQ educational materials but we also do a small amount of commercial work for non-USQ clients.

Like most groups working in the tertiary sector we are acutely aware of the "gales of creative destruction" and changes which are sweeping the tertiary sector. For example, three years ago USQ developed a student Intranet (USQ: USQconnect, 1998) and published quite a large amount of unit material. About a year ago USQ invested heavily in NextEd (NextEd, 2000). NextEd's mission is to "partner with higher education institutions to create, market and deliver education in student focused, virtual campus environments, via our multiple country server network." NextEd currently provides this service to USQ (USQ: USQ Online, 1999) as well as a number of other Australian and overseas universities. It is possible within the very near future that all student IT services will be outsourced to NextEd.

Within this highly fluid context it is critical that we position our small group to provide a valuable client focused service not provided by other groups. Our "niche" is the cost-effective development of small, interactive

learning objects which can be distributed as standalone programs or embedded in web pages distributed on floppy disk, CDROM or via USQconnect or USQOnline. Moreover, we work interactively with the lecturer in a way that allows them fingertip control over their content. Our procedures also allow lecturers to be confident in the development process and be assured that their project will be delivered on time. Within the USQ environment these learning objects are called COOL Tools (Creative Opportunities for Online Learning) and more information is available at the COOL Tools support site (USQ: COOL Tools, 1999).

Development principles

Without strategic principles it is possible to be continually buffeted by ever more turbulent technological developments. Below are some general principles which have, thus far, served us well.

Keep content independent of the deliverable

The lifetime of the deliverable product is becoming distressingly short. In contrast to the typical 5 year "no change" lifetime of a print based study guide it would be hard to imagine a CDROM or web site created in 2000 continuing to be used in 2005. While the lifetime of the deliverable might be fleeting the organisational and pedagogical structure of the content is enduring and for this reason it is critical to keep the content in a structured format allowing future versions of the materials to be developed easily. Examples of such structured content data files are presented later in this paper.

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 an IMM group and only return 3 months later to a completed project (often not the one they wanted). Creating highly interactive environments requires the content expert to be interactively involved in the development process and a structured markup language is one way of doing this. "Batch" orientated production models 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.

Schedule orientated development

As IMM and web development becomes more integrated into the mainstream activities of the university we need to adopt predictable schedule orientated production methods. Useful strategies include:

- consciously limit the scope of projects;
- emphasise the use of reusable code;
- separate program and data through the use of structured data files;
- use open and extensible standards for all data structures;
- make maximum use of existing tools and don't reinvent the wheel; and
- increase the visibility of project management through use of milestones and signoff points.

Representational richness

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 generally be regarded as "cold" while a movie adaptation of the same novel would be "hot" because the user has to "imagine" less when shown the movie. 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 automatically be more educationally 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 deeper levels of cognitive processing and increased 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 representational richness 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.

Interactive richness

Equally, different media treatments embody different levels of interactive richness. At a simplistic level the following is a continuum from less to more interaction:

- a textual description of a process e.g. photosynthesis;
- a textual description of a process with embedded activities requiring students to write answers; and
- an interactive simulation of a process requiring the student to enter values and predictions and explain the performance of the system.

Of course, these features of the media element are not invariant and depend on the interaction between the environment and the user. For example, the richest simulation might be used in a very simplistic way.

Just as selection of the appropriate level of "representational richness" depends on a careful match between educational goals and features of the student and the content, so too does the selection of the appropriate level of interactivity. Generally, higher levels of interactivity costs money and we need to make conscious decisions to ensure that this investment is justified.

Conclusions

In summary, we want a development methodology which allows:

- content to be maintained independent of the deliverable;
- content to be structured by the content expert;
- cost effective and predictable development timelines; and
- conscious selection of different levels of representational and interactional richness depending on the educational needs.

Developmental framework

Considerations of these issues has led us to adopt a two level development methodology made up of:

- an HTML based presentation and navigation framework containing
- embedded interactive objects.

HTML navigation and presentation framework

HTML and the browser provide the following major advantages for the developer:

- allows cost-effective development and presentation of text, graphics, audio and video;
- can be produced relatively quickly and cheaply by academics using appropriate web publishing tools and methodologies e.g. ILS-ML (Evans, 2000);
- 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);

- 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 plug-ins to enable additional functionality.

Perhaps the most significant weakness of pure HTML is that it provides limited opportunities for highly interactive applications and for this reason we need to use another level for the interactive objects.

While the focus of this paper is on the embedded interactive COOL Tools it is necessary to provide a little information about the HTML framework in which they are embedded. This is because the HTML pages provide most of the information as well as the navigational framework. If the user becomes disorientated in the HTML pages and either does not find the CTs or is overwhelmed by the environment even the most brilliant CTs will be useless. Many of our environments contain direct links to the embedded CTs e.g. the "Web enhancements" links in the MPA unit materials (USQ: MPA, 1998)

Currently most of our 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) which allows the content expert to quickly markup content in a way best suited to 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 desktop publishing operators within USQ. 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).

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 disoriented or "lost in hyperspace" (Conklin, 1987)

Embedded interactive objects

Java and the plug-in 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. 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 an HTML based navigation and presentation level containing 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 synergistically 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	COOL Tools
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 plug in
unique strengths	provides the navigational and the	high levels of interaction to solve

	presentation framework	specific educational problems
developed by	IMM group, USQ, NextEd or any other organisation	IMM group

The next section of this paper examines the CT approach in detail.

COOL Tools

CTs are small interactive objects with the following features (some of which are illustrated in figure 1):

- generally embedded into HTML pages but can be distributed as standalone executables;
- are designed to address a specific educational need and have a limited functionality;
- there is a separation between the engine and the data (content);
- the content is stored in a supporting content data file which is structured using XML compliant tags;
- the content data 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 user data to the local hard disk allowing the user to return to a partially completed exercise; and
- the CT can interact with other objects in its environment e.g. the browser, JavaScript, other web pages (HTTP), email (SMTP), web servers (CGI), other CTs etc.

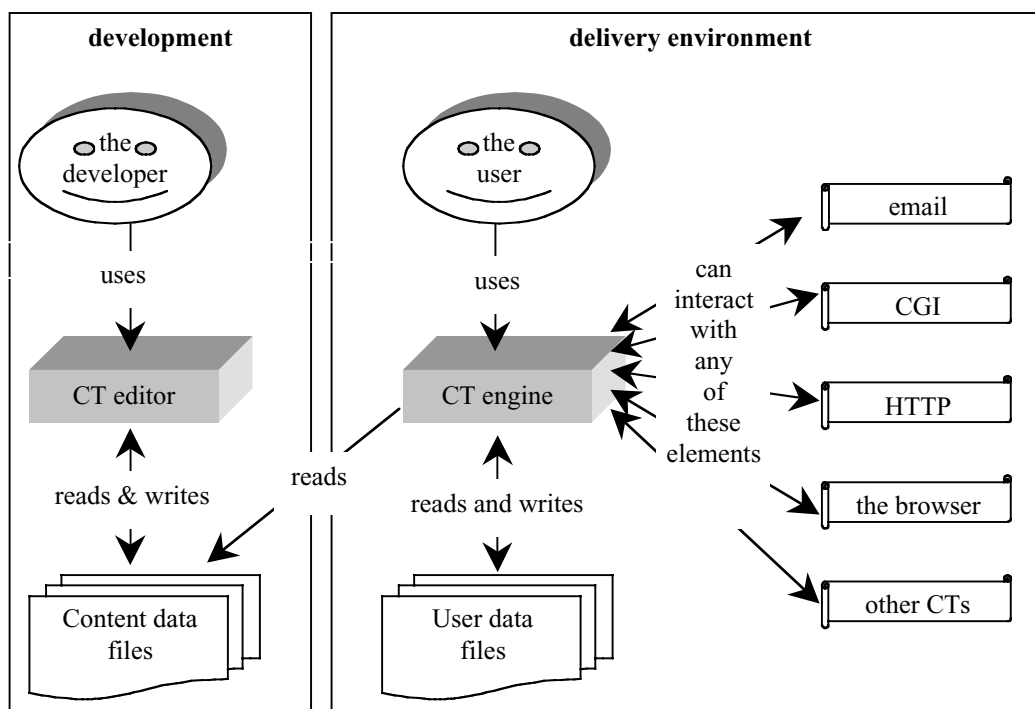


Figure 1: COOL Tool functional architecture showing the development and delivery environments.

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, it would be arrogant to believe that the same function would not be useful to the student. In fact some would say that the browser environment blurs the roles of developer and consumer.

Mirroring the functionality has been useful because it allows some lecturers to use the browser based delivery environment to create a user data file which is later renamed to be the content data file.

Example COOL Tools

Thus far eight CTs have been developed to do a number of functions (USQ: COOL Tools, 1999).

- graphic arranger
- text arranger
- interactive labels
- interactive numeric exercises
- media synchronisation
- question, answer and compare
- matching
- scenarios and timed responses

There would be at least 600 different applications of these throughout units offered via USQ Online (USQ: USQconnect, 1999), USQconnect (USQ: USQconnect, 1999) and on various CD-ROMs. The Master of Midwifery CD-ROMs (Evans, McDonald, & Fahy 1999) provides a good example of integration of these CTs into four university units. More information and online demonstrations of the COOL Tool initiative at USQ is available from the COOL Tool support site (USQ: COOL Tools, 1999).

The following sections examine several of these CTs.

Interactive Labels

The interactive labels CT (see figure 2) presents users 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 two types of "self test":
 - select the correct label from a pop-up menu (easier recognition task); or
 - type the correct label into the box (harder recall task).

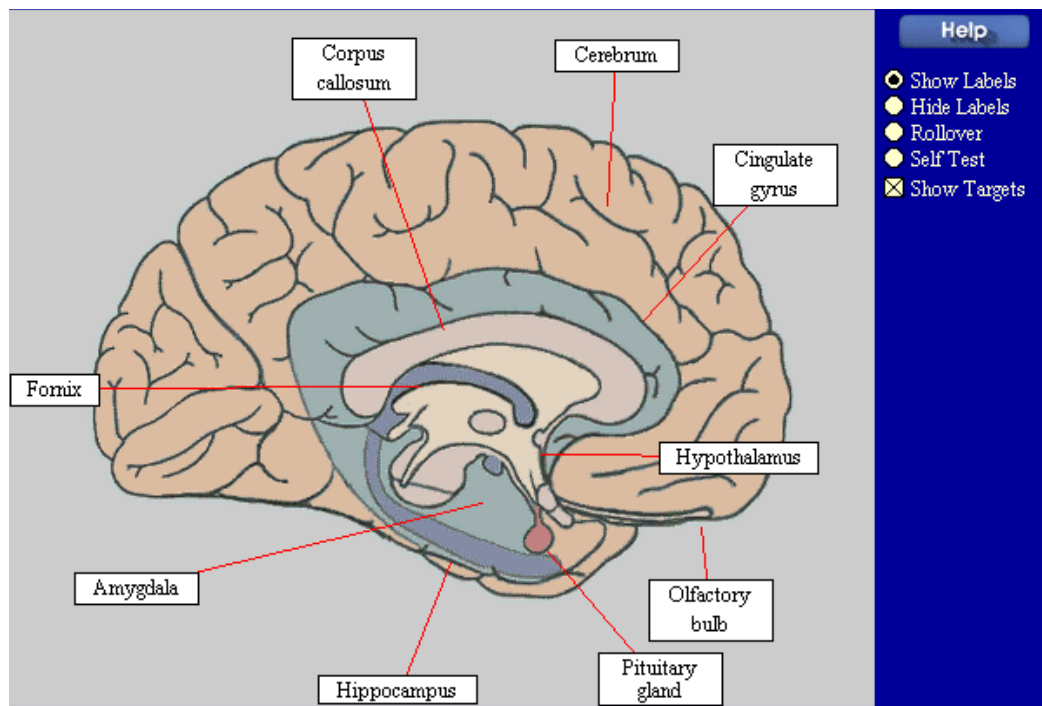


Figure 2. The Interactive Labels COOL Tool showing the label control panel

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 controlled environment providing immediate feedback.

The Interactive Labels CT is accompanied by an editor 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, and then drag labels, arrows, regions, and exemplar points onto the graphic. The data for a functioning interactive label exercise can be created reasonably quickly (less than 5 minutes) and it can be immediately proofed within a web browser.

Traditionally, to label an image the lecturer would mark labels on a printout 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 could take several weeks especially in fields such as physiology or engineering.

Thus, in addition to providing lecturers an easier way to generate and edit labelled diagrams, this CT also allows students to interact with the diagram in ways not previously possible.

Interactive Numeric Exercises

The Interactive Numeric Exercises CT allows the creation of an interactive exercise in any subject domain which requires the user to follow an 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, progressively more directive hints are given until the answer is finally supplied.

The underlying content data file contains a fully worked solution including formulae linking the fields as well as the series of directive feedbacks. Once the data file is created the finished CT is available within several hours.

The screenshot shows a web-based interface for an interactive numeric exercise. At the top, there are buttons for 'Print', 'Original Question', 'Random Question', 'Glossary', 'Help', 'Show Sample Soln', 'Show Progress' (with a checkbox), and 'Reset All'. Below the buttons, the 'Question' section displays a table with the following data:

		\$,000
Fair Value of Assets acquired	=	650
Cost of Acquisition	=	750
Goodwill	=	8
Amortisation per year	=	

A feedback box is overlaid on the table, stating: "Goodwill is the additional amount paid for the assets above the fair value of the assets acquired." Below the table, the 'Journal' section shows the following entries:

Entry			
Dr	Capital		
Dr	Asset Revaluation Reserve		
Dr	Retained Profits		
Dr	Goodwill		
Cr	Shares in Baxter Ltd		

The 'Worksheet' section shows the following entries:

Entry 30.6.98	(after 4 years)		
Dr	Capital		
Dr	Asset Revaluation Reserve		

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 primary strength of this CT is that it allows students 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, they get immediate feedback guiding them to successful completion of the activity. Because the fields are related by formulae it is relatively simple to provide:

- any number of randomly generated questions for student practice; and
- a "my question" facility in which the student can enter their own data into the question and the worked solution is provided.

Media Synchronisation

The Media Synchronisation CT (see figure 4) allows video or audio with accompanying image to be seamlessly 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 directly 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
- analyse a section of video over several weeks and submit this analysis in an assignment.

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

- preview a video without 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 users' computer allowing them to add to their work completed in the previous session.



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

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 of this CT has been to prepare an interactive bibliographic referencing exercise (see figure 5). As the user builds up the bibliographic reference by dragging elements they receive immediate feedback.

Of course the Text Rearranger CT "knows" nothing about the content and it might be used to drag historical events into a chronology, chemical steps into a reaction sequence or concepts into a hierarchy. 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.

Ongoing issues

The CT initiative is not without difficulties, some technical and some educational.

While Macromedia Director (and ShockWave) is in our experience the most robust and functional development and delivery platform, it still presents difficulties e.g. frequent releases of the ShockWave plug-in and the need for people to download the latest version. Some people are also reluctant to download and install yet another plug-in but increasing numbers of computers come with a version of ShockWave installed.

The Internet and browser environment provides a rich environment for CTs but this richness comes with dangers. There are many and varied interactions between the type of operating system (Win 95, 98, 2000, MacOS), the browser (different versions of Internet Explorer or Netscape Navigator), the myriad of plug-ins and user settings, access methods and server technologies. Moreover, developments and changes are occurring at an ever-increasing speed.

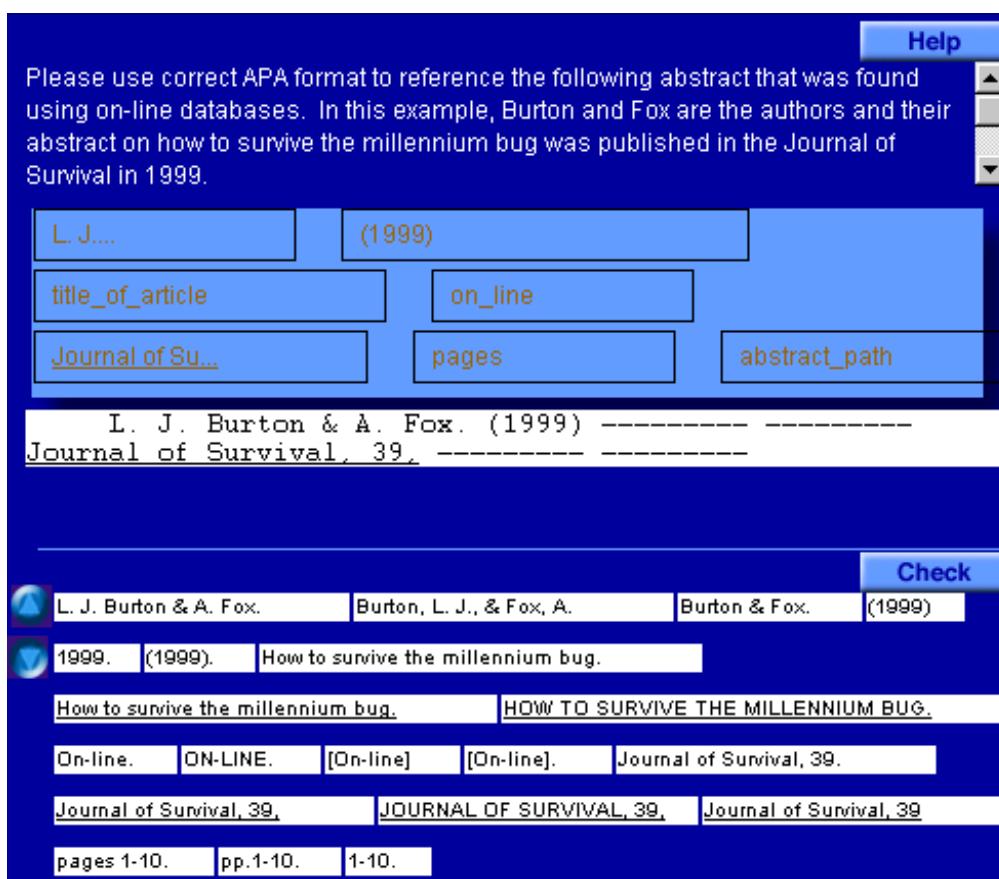


Figure 5: APA Text Rearranger giving immediate feedback as the student constructs a correctly formatted APA bibliographic reference.

The CT philosophy is built on the desire to rapidly develop 90% of what people want, rather than launch into a long and risky developmental process to achieve 100% of what they want. If an existing CT can be used, the interactive component can be delivered very quickly. If a new CT is required we work to tightly focus the scope of the planned CT while ensuring that it will be useful to others. Negotiating the scope of projects so that they fit into the CT initiative takes time and skill.

Conclusion

Within the current climate it is critical that our multimedia development group produces multimedia components in a cost effective and predictable way. It is also critical that our clients (content experts, instructional designers or external groups) have confidence in our development methodologies and are able to fully participate in the development. Focusing on CTs embedded in a HTML framework which may have been developed by others has been a very useful strategy in this environment.

COOL Tools are important because:

- they significantly increase our development speed and levels of reuse;
- their limited functionality allows us to more accurately schedule development;
- content data is maintained independent of the deliverable facilitating future development;
- the use of structured markup provides lecturers with finger tip control over their content and to interactively develop and proof their content; and
- the scaffolding provided by CTs allow content experts and instructional designers to use interactive objects without committing themselves to a lengthy development process.

Up to date information and demonstrations of the COOL Tool initiative at USQ is available from the COOL Tool support site (USQ: COOL Tools, 1999).

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