

# Developing Interactive Course Materials: Using HTML to Integrate Conventional and Internet Resources

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## Abstract

The specification of the hypertext markup language and the hypertext transfer protocol, and the availability of free software for viewing and serving hypertext documents has made it possible to develop a learning environment that begins to reflect constructivist theory. This is an environment that provides varying levels of interactivity ranging from simple point-and-click interaction to more sophisticated search techniques and manipulation of data. At Macquarie University the potential of these new developments has been realised in the teaching of Atmospheric Science. Students now have access to real-time and regularly updated local and international data as well as online textual and graphical information. Innovative use of material available on the internet does present unique difficulties and raises questions of copyright compliance. This paper explores these issues and the opportunities afforded by this new and exciting approach to teaching and learning.

## Keywords

*HTML, internet, interactivity, knowledge construction, multimedia*

## 1. Introduction

It is widely recognised through the findings of cognitive psychology that learning is a complex and dynamic process of knowledge construction, is knowledge dependent (that is, prior knowledge is used as a framework to act as a reference point to make sense of new information and thus transform it into useful knowledge) and is highly tuned to the situation in which it takes place (Resnick, 1989; Glaser 1991; Brown, Collins and Duguid, 1989). Consequently, researchers and practitioners are increasingly focussing less on what knowledge should be taught and more on how the learning environment and student experiences can be organised to maximise knowledge construction.

A very useful framework for developing programmes of study based on constructivist theories has been provided by Jonassen (1994). The framework proposes that purposeful knowledge construction may be facilitated by learning environments that:

- provide multiple representations of reality, thereby avoiding oversimplification of instruction by representing the natural complexity of the real world;
- present authentic tasks (conceptualising rather than abstracting instruction);
- provide real world, case-based learning environments, rather than predetermined instructional sequences;
- focus on knowledge construction, not reproduction;

- foster reflective practice;
- enable context and content dependent knowledge construction; and
- support collaborative construction of knowledge through social negotiation, not competition among learners for recognition.

In higher education, the prevailing traditional view of learning as a process of knowledge acquisition is still widely accepted and practised. Combined with time and resource pressures, this often presents a challenging obstacle to the introduction of the innovative practices outlined above. In the teaching of Atmospheric Science, techniques such as the incorporation of multiple representations, authentic tasks, and case-based learning environments into teaching programmes have been difficult to implement in the past. This is due to a variety of reasons including the highly technological nature of the content (e.g. satellite imagery and complex three dimensional global circulation models) and the difficulty of obtaining current data and images of recent atmospheric conditions.

This is changing, however, with the recent development of the hypertext markup language and the hypertext transfer protocol. It is now possible to develop instructional materials and practices that utilise interactive internet sites, provide student access to real-time and regularly updated local and international data, as well as online textual and graphical information. This has made it possible to provide a learning environment that begins to reflect constructivist theory. This environment provides varying levels of interactivity ranging from simple point-and-click interaction to more sophisticated search techniques and data manipulation. Most importantly it is a technology that is potentially accessible to all academics.

This paper will discuss how the latest internet technology has been utilised in the teaching of Atmospheric Science at Macquarie University. An overview of the technology and its various levels of interactivity will be followed by a discussion of the impact of the technology on course design and learning. Finally, emerging issues that need to be addressed with the incorporation of teaching materials from the internet will be introduced and solutions briefly discussed.

## **2. An Overview of the Internet Technology**

The specification of the hypertext markup language (HTML) and the hypertext transfer protocol (HTTP) and the availability of free software for viewing and serving hypertext documents has made it possible to develop interactive multimedia course material that can integrate information from varied sources such as traditional lecture notes, books, photographs, audio, video and the internet. Popular software for viewing hypertext documents includes Mosaic and Netscape. These are both available for Windows, MacOS and Unix environments and both support the transfer of documents across the internet. They are often referred to as internet browsers, or simply browsers.

The hypertext markup language is a simple markup language for hypertext that supports basic textural elements such as headings, paragraphs, simple fonts, lists and tables. It can be written using any editor or word processing software. Links to other documents and media such as images, sounds and animations are made by means of a uniform resource locator (URL) (Connolly, 1995) which specifies the communications protocol used to transfer the resource, the computer address, port, the file's or directory's path and any parameters or query information (Berners-Lee, Masinter and McCahill, 1994; Fielding, 1995). Images in gif or xbm format can be incorporated directly in a page (some browsers also support jpeg) while other image formats, sound, movies or anything else can be linked to and viewed if an external viewer is available. Thus any type of text, data or media can be incorporated if software to edit, display or otherwise manipulate the information is available.

The simplicity and flexibility of HTML make it ideal for creating simple interactive multimedia teaching resources. Graphics can be incorporated by scanning figures and photographs, or by generating them directly from a computer. Sequences of still images can be put together to create movies in formats such as mov, mpeg and quicktime or converted from video if the appropriate technology is available. Audio can similarly be incorporated. Existing material available on the internet can be incorporated directly via its URL. Such teaching resources can be stored locally on a personal computer (PC) and disseminated in several ways: via disk; transferred over local networks; or reside on a file transfer protocol (FTP), Gopher, or HTTP server attached to the internet. Naturally, to utilise internet links, PCs must be connected to the internet.

Using simple levels of HTML interactivity, essentially anything that was formally given to students on paper (course outlines, lists of references and other resources, lecture notes, handouts, seminars and messages) can now be made available electronically. These simple applications can be extended to produce material such as full study guides and electronic textbooks (e.g., Electronic Textbook - TDP (Department of Atmospheric Sciences, University of Illinois at Urbana-Champaign (1995))).

More advanced interactivity can be achieved using imagemaps and forms. Imagemaps enable an image to be sensitised so that clicking in a particular region will cause an action. The action to be carried out is typically specified as a URL and could be information about a particular geographic location on a map such as annual or current temperature or it could be information about some instrument on a picture of a weather station.

HTML forms allow the selection and input of data via buttons, menus, scrolled lists and text boxes. The information is fed to a program on the server which processes it and returns the appropriate response. Applications include quizzes, data extraction and plotting, student comments, interfaces to experiments or virtually anything—it is entirely up to the teacher's imagination (and technical ability or support).

Examples of the use of the above in teaching Atmospheric Science at Macquarie University are given in the next section.

### **3. The Impact of HTML on Course Design and Learning**

Current implementations of HTML in Atmospheric Science at Macquarie University span several courses in the programme. The material ranges from simple uses such as course outlines and lists of resources, through simple interactive multimedia materials utilising resources from diverse sources, to fully interactive material incorporating quizzes and data extraction and plotting. The innovations are used in specific sections of all but one of the units in the programme. Each unit is taught using a typical weekly pattern of two lectures and a three to four-hour session which could be described as a combined tutorial / practical session. The session is used in several ways - discussion between students and staff, introduction to instrumentation, field work and providing additional resource material in the form of visual images, computer models and simulations to support concepts introduced in lectures. Computer-dependent sessions are conducted in a dedicated PC laboratory, where each student has one-to-one access to a PC. The material is available for each class at scheduled times and whenever the laboratory is not in use.

What impact has the use of HTML had on course content and student learning? To answer this, three examples have been chosen that reflect components of the learning environment proposed by Jonassen (1994). These deal with:

- simple levels of interactivity which have enabled multiple representations of reality;
- fostering the beginnings of reflective practice; and

- more advanced levels of interactivity which have enabled authentic tasks to be set based on real world practice.

### 3.1 Multiple representations of reality


In a component of Applied Meteorology students are introduced to remote sensing. In particular, meteorological applications of satellites and radar. Lectures are used to introduce the concepts and the practical sessions to provide examples of the application of these concepts.

The practical sessions utilise HTML to combine diverse types of material such as photographs, still and animated satellite and radar imagery and visualisation of model output. Some of these have been scanned from conventional resources or constructed locally, but most have been collected from the internet. The representations are linked with appropriate text explanations, stimulation questions for students and a glossary of terms. This provides students with the flexibility to control their own learning sequence by making their own decisions about which representations and explanations are appropriate at any given time.

The internet examples can help to provide realistic applications of satellite and radar imagery. Images of recent occurrences such as tropical cyclones and bushfires reinforce that the concepts being taught are based in reality and have immediate relevance. Material can remain constant from session to session or can be automatically updated by including an appropriate URL. A good example of automatic updating is daily sea surface temperature (Division of Meteorology and Physical Oceanography of the Rosenstiel School of Marine and Atmospheric Science, 1995).

The ability to collect information from a large number of sources has enabled the introduction of case-based studies of particular observed phenomena. A section on microbursts, for example, utilises material collected from diverse sources including photographs, still radar images, animated radar images, a still model simulation and an animated model simulation. Some suitable examples were readily available at an internet site (figure 1) and were easily incorporated into the course material.

**Microbursts**

 **Image** and **Movie** of a New Mexico microburst (64K,149K)

Microbursts are relatively small (several km across) regions of surface and wind **divergence**, caused by thunderstorm downdrafts. They show up in a single doppler **radial velocities** as small patches of opposite velocities in **range**.

A mature microburst is centred 15km due west of the radar in this still image. Peak radial winds are 15m/s towards and 8m/s away from the radar. The large white patches are ground clutter from the Sandia Mountains in NM, and the ambient winds are gentle southwesterlies. The movieloop contains 1 minute updates for 12 minutes of the microburst.

Microbursts are often visible as falling raindrops and surface dust get entrained in the rotor-like head of the outflow. Here is a **photograph** of a separate microburst event in Albuquerque.

A numerical simulation of a microburst was conducted by JR Anderson et al at the University of Wisconsin; a movie of their results can be found **here**

Figure 1. Some source material for the Microburst Case Study. (Massachusetts Institute of Technology, 1995). Interactive points are bold and underlined.

In many instances point-and-click interactive techniques are simply utilising materials such as videos, slides, textbook images and explanations that are already available to students in the library or elsewhere. What this technology has enabled is the ability to collect and organise this material, supplementing it with more recent examples drawn from the internet and to place it in one location. The material is accessible to students throughout the entire course, it can be easily updated as new examples become available, and most importantly it can be accessed through multiple pathways as determined by student needs and interests.

### 3.2 *Fostering reflective practice*

In observing students' use of the material discussed in the previous section it was apparent that some did not take the time to read the text and try to understand the information. These students were typically the less motivated ones. To encourage more substantial levels of engagement and the development of reflective practices, quizzes were inserted into the material. In some instances, where particular information was deemed critical, progression through the material was made requisite upon successfully completing a quiz. In this way, the quizzes performed the function of encouraging students to focus their thinking and reflect on the information being presented. They were used to flag important concepts and ideas thus providing students with an indication of what knowledge was regarded as strategic for a particular section of work. The quizzes were also grouped together at the end of each course section to allow easier access for revision purposes.

Although the quizzes are anonymous, the results of each attempt are logged along with the date, time and machine from which they are carried out. This enables later analysis of what questions are poorly done, how they are re-attempted and how many attempts are made. From this it is readily apparent which questions are not understood and whether students choose to re-read the material provided and try again or simply arrive at the correct answer by guessing. This provides valuable feedback to the lecturer, giving an informed basis for the development of subsequent lectures in the series. It highlights areas that need additional emphasis and helps in the selection of assignment tasks.

### 3.3 *Real world tasks*

The use of advanced HTML interactivity has enabled the provision of user-friendly access to two very important data sources used in professional practice - the Macquarie University Automatic Weather Station (AWS) and the Bureau of Meteorology.

The AWS reports various meteorological data such as temperature, pressure, relative humidity, incident radiation and precipitation. The data are used for examples in lectures, student assignments, and comparison with practical and field data. These uses extend across all undergraduate levels. Student use of the AWS was previously restricted to data pre-selected by the lecturer. With the introduction of an HTML interface to the AWS (figure 2) students can now select and manipulate the data themselves. They can determine which variable (temperature, pressure, humidity etc.) they want to work with, the time period, and whether they want a graphical representation or actual measurements.

<b>Atmospheric Science, School of Earth Sciences, Macquarie University</b> <b>Automatic Weather Station Interface</b> ( <a href="http://atmos.es.mq.edu.au/aws/">http://atmos.es.mq.edu.au/aws/</a> )			
Select the variable and day you would like, graph or data and inline or external. Then press the 'Submit' button.			
<b>Bulb temperature</b> >	<b>Today</b> >	<b>Graph</b> >	<b>External</b> >



Figure 2. A representation of part of the Macquarie University Automatic Weather Station interface (Love, 1995)

The AWS HTML material also provides background information on what is measured, the instrumentation (including pictures) and pictures of the actual site and instrument mounting. Internet links to other Sydney data are also given. Some of these are automatically collected and archived at Macquarie University and are then made available via a similar interface to that used for the AWS.

Along with other universities, government departments and private industry, Macquarie University receives real-time national and international meteorological data from the Bureau of Meteorology. This data is in MCIDAS format and the MCIDAS software is used for manipulating and displaying the data. It provides satellite data, surface observations, soundings and model output. In the past its use was restricted because of several difficulties: it requires a particular operating system (OS/2); the data are big; and the command syntax is very unfriendly. There were only a limited number of older machines available for running OS/2 and students lost valuable contact time transferring data and learning the command syntax. Due to these constraints, use was restricted to two small third year classes. The introduction of an HTML interface overcame these difficulties and has made the MCIDAS data available for use in all atmospheric science units.

Both students and staff have benefited. Students now have independent access to data outside their designated contact times. Teaching staff can access data and identify and save interesting events despite having differing computer hardware. The interfaces have also enabled the development of teaching material that is independent of graphical and database software thus, if changes are made in the future, all that is required is to replace the software behind the interface, not the actual teaching materials.

Access to the AWS and MCIDAS data sources has made it easier to provide a learning environment that more closely reflects the real world context. Students can be given tasks that require them to work with authentic data used in professional practice. For example they can compare their own data collected in field observations with that collected by the AWS at Macquarie and the Bureau of Meteorology (MCIDAS). They can also relate and compare current weather conditions to real time data thus making it easier to bridge the gap between theory and practice. The experience of a sudden cold front or hail storm for example, can be viewed through the eyes of a professional weather forecaster by analysing the data and graphical representations provided by the AWS and MCIDAS.

The three examples given indicate the potential HTML internet applications have in developing and structuring courses that more readily reflect constructivist learning environments. In this instance, innovations have only been introduced to sections of the overall programme. To be more effective it will be necessary to extend the impact over the entire programme and present a more coherent approach.

#### **4. Utilising Internet Material and Dealing with Associated Problems**

The examples in the preceding section illustrate the valuable contribution internet resources can make to student learning. However, utilising material available over the internet however, raises unique difficulties. These include: undesirable or distracting material, irrelevant material, speed, reliable connection, standard formats, the possibly changing and transient nature of the material, and copyright issues. The way in which some of these have been overcome are discussed in this section.

The scheduling of classes reliant upon access to material from external sites faces the problems of delivery speed (particularly for sites outside Australia) and reliable connection. The latter is dependent upon both the network between the browser and the server being fully functional and the server being available. For material that is not returned from an imagemap or a form, these difficulties can be overcome with the use of a proxy server operating a cache. In this situation, all requests from the browser are sent to the proxy server which obtains the required document from the specified server and keeps a copy of it. If the proxy server already has a copy of the document it returns this to the browser without contacting the server. Thus if teaching material is worked through prior to a scheduled session the required documents will be cached and hence available to students regardless of external connectivity. Caching also has the obvious effect of dramatically increasing speed. Similarly, if during a session a student requests a document that has not been cached, it will be cached and all subsequent requests by others will be responded to very quickly.

In order to control student access, the proxy server can be instructed not to contact the server if it does not have the requested document. Thus only pre-selected material is available to the students. This has been found very useful for making pre-selected internet resources available to a large first year class. This can also overcome the problem of students being distracted by linking to other material not related to the task at hand.

Another way of overcoming these problems would be the use of mirroring. This involves the replication of part or all of the material on a server and is commonly used for heavily loaded sites. Some sites specify that they may not be mirrored as they see this as a breach of copyright. Caching could be viewed in a similar way in the future, especially if the cache is non-volatile or documents are cached for a long time.

Copying, locally storing and incorporating part of a document obtained from the internet (including images, icons and text made available over the internet by any means including FTP, Gopher, HTTP news and e-mail) in teaching material will involve copyright issues. In the absence of comprehensive guidelines, material for this course was treated in the same way as would be the case for conventional material (Brinson and Radcliffe, 1994). Specifically, the copying of a reasonable amount for use in teaching was regarded as fair use. Therefore, to copy and use a figure was considered acceptable if the source was correctly acknowledged and access was restricted to the students in the class for which the material was intended.

In the Atmospheric Science Programme at Macquarie University, this access restriction is achieved by two means. Firstly, access to all course material is protected by a username and password unique to each course. Secondly, as an additional security measure, access is restricted to particular machines, e.g. those within the Earth Sciences domain (es.mq.edu.au). These restrictions and security measures are also used to prevent unauthorised access to the Bureau of Meteorology data which is subject to strict contractual arrangements and may not be redistributed.

The ease of copying material and incorporating it in HTML material makes it possible for those who are not familiar with copyright to inadvertently commit an offence. In particular, authors of HTML material must be aware that:

- the absence of a copyright notice does not mean that something is not copyrighted (this includes images, icons and text made available over the internet by any means including FTP, Gopher, HTTP, news and e-mail) (Templeton, 1995); and
- copying, altering and re-distributing material is likely to breach copyright, depending on the degree and nature of the alteration.

Similarly, all care must be taken not to commit plagiarism. For example, if material is included in an HTML document via a link, it must be made clear that it is the work of someone else.

It is also important to consider the copyright of any teaching materials that one develops and makes available over the internet. There are particular difficulties in enforcing copyright law involving the internet due to the ease of copying material, the difficulty in identifying those breaching the copyright, and the different international laws regarding copyright.

## 5. Conclusion

In this paper, the use of HTML for preparing interactive multimedia teaching resources incorporating material from diverse sources has been described. Particular examples have been given to illustrate

how this has begun to contribute to the development of learning environments that facilitate purposeful knowledge construction. At this stage the innovations have only been introduced into sections of the programme. Preliminary feedback does indicate a positive response from staff and students and a more substantial evaluation is underway. Future plans are to extend this approach into other sections of the programme and further develop HTML to promote communication and student interaction. This should facilitate more avenues of contact among students as well as between staff and students and open the way for the introduction more collaborative group-based learning exercises. This new approach to teaching and learning also offers tremendous opportunities for offering more flexible learning patterns to students and the delivery of courses to remote students and campuses.

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