

Beyond HTML: Creating extensible teaching resources using database and Internet technology

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ABSTRACT

In the past few years as internet technology has become an increasingly important delivery mechanism in teaching and learning computing subjects, active research has been undertaken in attempt to utilize the technology and improve the quality of the resources used by learners.

This paper discusses the development of a knowledge and content management system that is evolving to manage Learning Objects in a teaching environment. In the system, feedback mechanisms are being implemented to capture both lecturer and student knowledge and maintain the context of that knowledge.

Keywords

Computing Education, Computing Practice, Web-based learning, e-learning, Learning Objects

1. INTRODUCTION

During the mid 1990s, the author undertook much development work on delivering teaching resources in an HTML format. Conversion of existing electronic material was a labor intensive and time-consuming task, with each page having to be constructed individually into the HTML structure. The introduction of web authoring tools such as Microsoft's FrontPage made this task less demanding, but still each page was a separate entity. Further, the problem of keeping the content current and accurate became increasingly difficult. With internet technology moving to dynamic pages, in particular where the pages are served from a database, an

opportunity to address these issues presented itself.

This paper will first look at the existing HTML teaching resource solution, then discuss the development of a database prototype, and finally, present some initial findings from a student trial. The question as to whether it is feasible and workable to convert existing teaching resources to a database solution is explored.

2. THE HTML SOLUTION

A significant advantage of creating material in an HTML format is accessibility. When content is presented in this format, particularly if it is placed on an Internet connected platform, it will allow access in the lecture theatre, computer laboratory or at home. As HTML is a common format, the material can be consistently displayed on a wide variety of computers across many operating systems.

The primary drawback is the effort required to construct each page independently. If an ordered structure (taxonomy) is developed then positioning each page in this taxonomy can become difficult. In a printed book, page numbers keep a sense of order and position, but replicating this on a web page (commonly by using forward and back buttons) is a time consuming task, and is implemented in the same way a sequential update was achieved when tape drives were used to store database records.

Embedded Java scripting was used to simplify this but unfortunately during page construction the JavaScript is replaced by a place-holder and needs to be viewed at run-time in a web browser, in order to check for accuracy.

Cascading Style Sheets were introduced with HTML 4, which allows for better control of formatting and some independence from the strict formatting imposed in

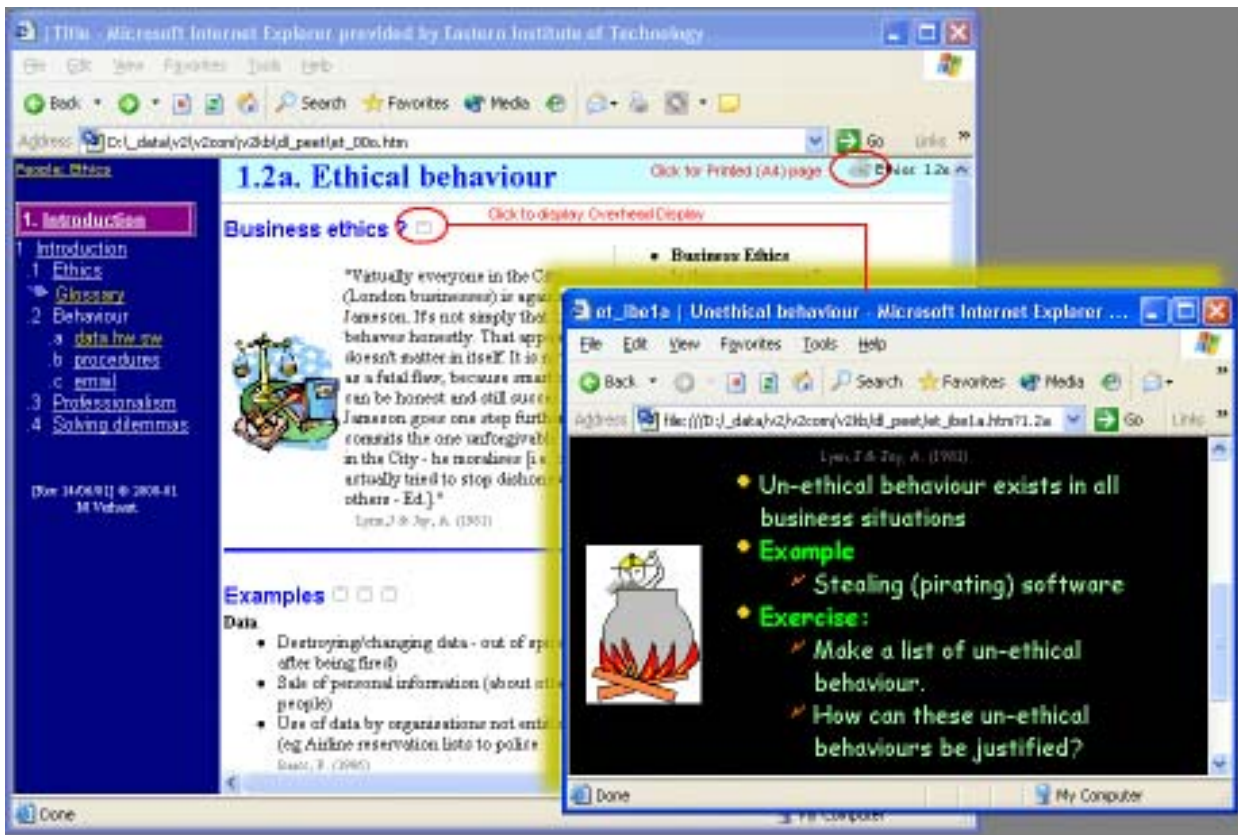


Figure 1: HTML solution showing notes and display modes.

earlier HTML specifications. Unfortunately, this required all earlier HTML pages to be adjusted to take advantage of the Cascading style sheets.

Ad-hoc enquiries were possible using Search facilities provided by the web server. The major drawback of these search results was the inability to maintain the context of the found web pages, with a random list of web pages delivered to the end-user.

Accuracy and reliability of the pages also became a significant issue. With approximately 4000 pages, the ability to keep them accurate became increasingly difficult (as an aside if 1 minute was to be spent checking each page it would take more than 65 hours to check each one!). Often students would either verbally inform, or e-mail the lecturer to indicate a page had some inaccuracies. Matching up comments with the problem was a time consuming task, and more often than not pages were left as they were. In one recent case, a student indicated that a modern, multimedia PC was a 486 with 16MB RAM. When questioned, they indicated it was in the online material.

2.1 The structure of the HTML solution

In order to deliver learning resources to students, two separate modes were developed. For the first mode, content was made available in a book format. Many of the students prefer to read the notes on paper, so the ability to produce content in a book format was desirable. Secondly, when delivering the content an overhead display format is required. A workable HTML structure evolved where each web page was designed to fit on one A4 printed page, and embedded graphic linked sections to a corresponding OHT. This is shown in Figure 1 and is explained in detail by Verhaart (2000).

3. THE DATABASE SOLUTION.

As Internet technology has evolved, a move to database driven web sites has occurred and the opportunity to re-develop the content delivery system in a database presents itself. Many of the drawbacks inherent in a hard coded system can be addressed and user interactivity also explored.

With this in mind, the author undertook to develop a prototype of a database that could be used to deliver

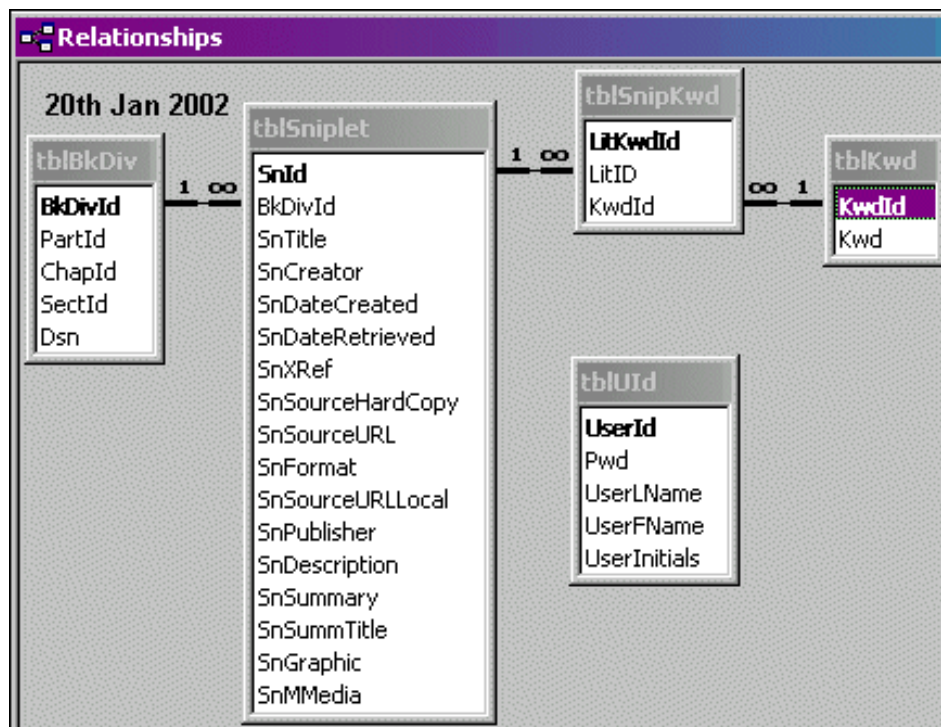


Figure 2: Initial Snippet Schema.

a set of teaching resources that would overcome some of the pitfalls highlighted by the HTML prototypes.

In order to proceed, a preliminary schema was designed that would satisfy two basic requirements, that is:

- ◆ Content must be displayable on an OHP; and,
- ◆ Must have an equivalent hard copy version.

As in all databases, it is important to work out the smallest workable unit or entity. After several prototypes, the content fragment that proved to be most workable was

- ◆ a piece of knowledge or information that could be represented by one overhead transparency.

In order to provide a way to refer to this, the term "*Snippet*" was coined. In a sense, a snippet is a specification for a type of learning object. The term learning object is grounded in an Object-Oriented paradigm and, as defined by the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE), is any entity, digital or non-digital, which can be used, re-used or referenced during technology-supported learning. (IEEE, 1999). Others, such as DLNET introduce pedagogy into the definition as, a structured, standalone resource that encapsulates high quality information in a manner that facilitates

learning and pedagogy. It has a stated objective and a designated audience. (DLNET, 2002).

These definitions are very broad and include not only the computer-based components, but also people, places, things and ideas (Wiley, 2000). For the development of a computer-based content management system, a clearer definition is required, hence the term snippet was coined.

The next step was to determine the technology that would be used to create the Prototypes. Microsoft's Active Server Pages (ASP) was selected for three main reasons. First, ASP is based on Microsoft's Visual Basic and this was within the skill set of the author, and secondly, MS-Access is easily integrated. Further, there are advantages with prototyping in MS-Access as all the necessary tools are available (File creation, relationships, forms and reports). Finally, a free web host called Brinkster with sufficient features to implement a solution was found. Details of the knowledge interrupt required to learn about the technology is explained in a paper by Verhaart and Jamieson (2002).

A simple prototype was developed. The essential attributes of the snippet entity included a persistent identifier, title, description (for the notes) and summary (for the Overhead). Dublin Core metadata descriptors (1999) were used where possible. Secondly, the snippets need to have some imposed order. Guarino and Welty (2002), refer to this as a "backbone

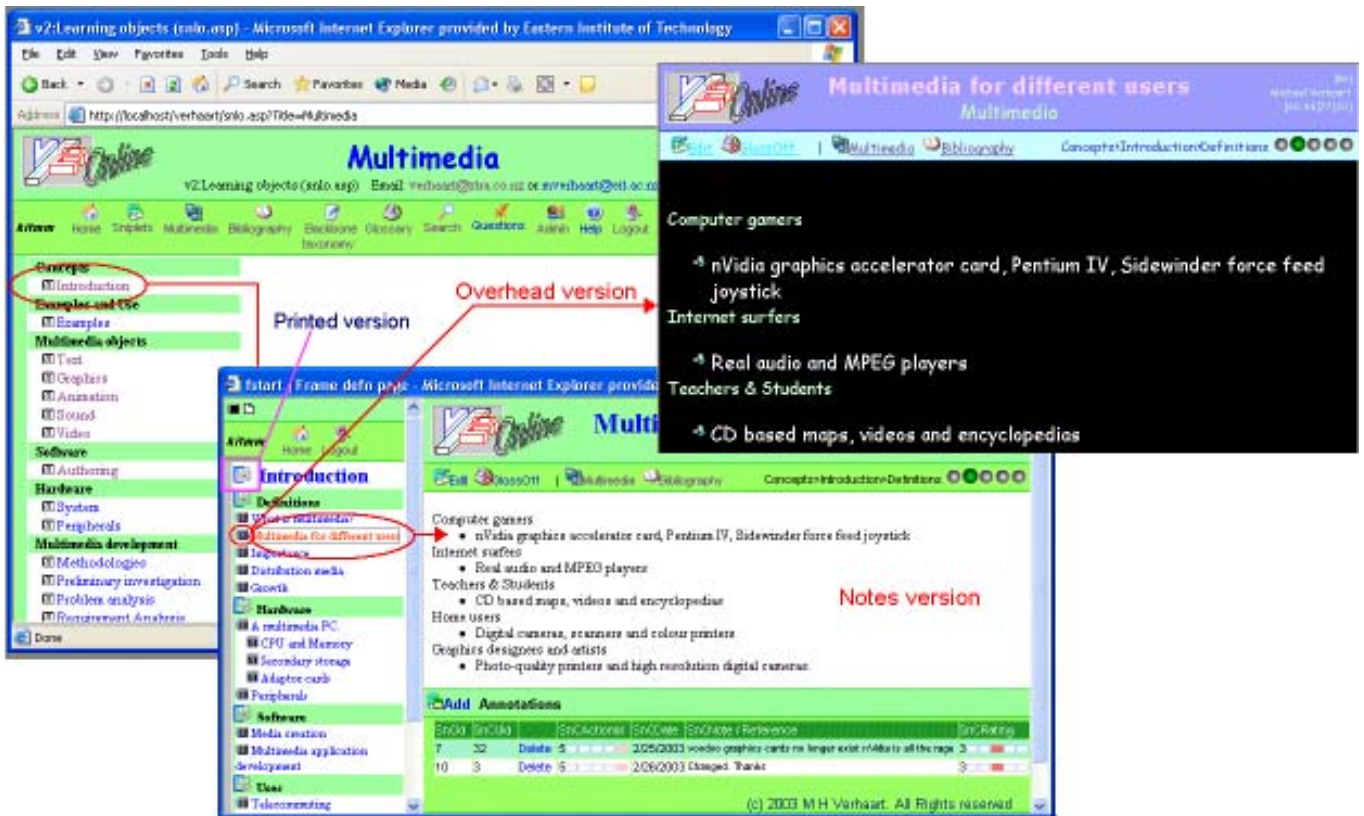


Figure 3: Snippet database showing Backbone taxonomy, Notes page (with annotation) and overhead version.

taxonomy". At the stage when the prototype was being developed the author was following a book metaphor, so termed this the book division. A sample schema is displayed in Figure 2.

Entities to manage users (tblUID) and Keywords were also included.

To demonstrate the viability of the structure an MS-Access database was built based on an Internet Course that was being delivered. The viability of the structure was established, but many extensions and modifications emerged. The significant additions were;

- ◆ the addition of the annotation entity, which was attached to the snippet entity;
- ◆ A bibliographic entity that could be referenced by any snippet;
- ◆ A multimedia entity, so that multimedia elements could have associated metadata, such as a description, and be referred to by multiple snippets, and,

- ◆ An independent glossary entity that could be cross referenced by the system when either snippet descriptions or summaries were created.

While these changes were evolving in Windows/MS-Access, a parallel Brinkster/ASP/MS-Access solution was being developed (Figure 3). This involved splitting the database into a front-end/back-end, and rewriting all of the form handling (front-end) in ASP and working around the idiosyncrasies of both the language and the hosting solutions.

3.2 Extensibility

Building the content management system using a database solution allows for a wide variety of extensibility. From a student perspective, the system can include student knowledge via annotations. It is also possible to record student movement in the database, enabling some scaffolding to occur, for example, the system could indicate which pages have already been visited. From a course developer's perspective, the ability to collaboratively build a course

by creating snippets is viable, as the structure is clearly defined.

From a computer technology view, there are several relationships that can be automatically generated (dynamic extensibility), and this is a real strength of the database approach. Some examples include:

- ◆ A table containing keywords with definitions can be dynamically referenced when displaying either a notes page or a summary (overhead) page, and tool tips created on the fly;

- ◆ A table containing multimedia elements can be used in reverse to display all of the snippets that use the element; and,

- ◆ The bibliography table can be used to display snippets that refer to the specified entry.

4. EVALUATION

Once a workable system was developed, it was trialed on a first year degree Internet class. To encourage participation a small assessment item was attached, where the students were asked to add an annotation to one of the snippets. Technical difficulties and time constraints meant that this part was not successful, but constructive feedback on the user interface and structure was gained. So that the students were not disadvantaged, material from the database was distributed in printed form.

Since then, two multimedia classes have had their content delivered in this new format. At this point in time, the most pressing issue revolves around user and password codes, where students forget their passwords, or on uploading a new database the passwords revert to an earlier state. The initial design requires each content area to have a separate user/password pairs and this too is causing unnecessary problems.

4.1 Pedagogy

From a pedagogical perspective, the system allows for multiple mode delivery. The system can be used to deliver lectures and provide attached notes to a fine grained level.

The ability to add annotations extends the course material from an information delivery mechanism to one where students can add their knowledge and interact. For example, a snippet described a graphic card to which the following annotation was attached "voodoo graphics cards no longer exist". Further, social interaction is

possible via the annotation feature, and it is interesting to note that initial comments were of the form "hey this really works"!

A comment that features in informal discussion is, "how do you monitor the quality/accuracy/appropriateness of the annotation?" In the system, an administrator has the necessary rights and privileges to modify/erase any inappropriate annotations.

The ability to rebundle snippets is also being explored so that the domain space can be controlled.

5. CONCLUSION

There is still much work to be done. Using extensible Markup Language (XML) to manage the content and data in the database so that the system can be manipulated by a variety of technologies is one direction. Looking at metadata structures to allow for better control of media elements, and redesigning the structure to allow for improved multi-user updating and usage is also being considered.

The system is work in progress, and can be viewed at <http://www25.brinkster.com/verhaart/>

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