Using the Internet to Teach Information System Case Studies

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Abstract

An internet, browser-based, computer-supported learning system was designed and built by the MSIS Department to serve primarily as an assessment vehicle for business students. Now in its second year of operation it has migrated across computer platforms and been completely redesigned to become a university resource. Hundreds of students use CSL daily. This paper will outline the development of CSL and discuss our work in connecting a taxonomy of knowledge with the multimedia assets needed for learning and assessment. In particular, its use in teaching Information Systems and case-based courses and the lessons learnt will be explored. The implications for self-directed study and our university's goal to provide life-long learning will be presented.

1. Introduction

In addition to well-established tertiary institutions, New Zealand has experienced a rapid growth in occupational training standards and the necessary infrastructure of training organisations and establishments to support them. The public and private sector are committed to meeting the occupational needs of New Zealanders for the next decade and beyond.

In relatively the same time-frame one notes the phenomenal world-wide growth of the internet spurred on by an easy-to-use, graphically-based interface. In New Zealand with a population of 3.6M, a land mass of 266 000 square kilometres, and 14 sheep per person, there are approximately one million computers that use or could be upgraded to use the internet. The percentage of computer users joining the internet is exciting and carries with it the usual significant commercial possibilities.

New Zealand has a fully digital telephone system and significant competition exists for the consumer's business. Moves by the major telephone company to place free internet service points in every school and access points in every community lead one to believe that internet services will rapidly increase in functionality and bandwidth while remaining well within the budget of many families.

At the academic level, the majority of first year students at the University of Auckland School of Business own multimedia computers and more than thirty percent used the internet frequently from their homes before enrolling at the institution. The University recently signed a strategic agreement with a major internet service provider to gain access and bandwidth well beyond what it could have arranged using internal university resources. With an enrolment of approximately 25,000 students we now have the capacity to handle more than 6,000 simultaneous users through internet communications. The university is uniquely positioned to serve the nation with its knowledge resources. The challenge is to re-engineer these educational resources to suit the new medium.

As one answer to this challenge, a computer-supported learning (CSL) environment has been developed in the past two years by the Management Science and Information Systems (MSIS) Department of the University. CSL was built around the popular internet browsers and was designed to support administrative, communication, instructional, resource management, and assessment modules. This internet-based resource has become a platform for disseminating our knowledge resources using multimedia technology.

2. What is CSL?

Computer supported learning (CSL) is a comprehensive structure for the organisation of the curriculum and the provision of individual learning programs, on-line access to instructional materials, electronic mail, resource booking, on/off line assessment, while providing the academics with audit trails and competency records. CSL was initially built on a Microsoft NT server using SQL 6.0. with Delphi and Java modules. It has since migrated to a multi-processor, Sequent NT and uses a software architecture that delivers active pages generated by MS ASP + COM objects. The CSL data model includes more than 200 tables and 1000 attributes and is managed using an industry standard CASE toolset (ERWIN). Aspects of CSL's data model replicate those of the Registry with the result that the university's administrative systems can update enrolments in CSL as well as up-load marks from CSL. Naturally, CSL is platform independent since the browsers mounted on Macintosh or Windows systems worked equally well. In addition with the new software architecture CSL is database independent as well.

In this paper we will focus on two CSL features as they address the issue of life-long learning: the representation of knowledge and the provision of on-line assessments.

3 Bodies of knowledge

In the CSL data model all learning is related to what might be called a career, discipline or a body of knowledge (BoK). Many professions such as medicine, accounting, mathematics and information systems have well articulated taxonomies. The New Zealand Qualifications Authority has technical training standards that also form BoKs since they provide a framework for learning and assessment.

The body of knowledge (BoK) for information systems has been developed over a number of years and based upon numerous studies by individuals and professional organisations [1,4,5,6,8].

In the past year, IS'97, has been proposed as a model curriculum by the AIS, ACM and DPMA [5]. IS'97 details hundreds of knowledge elements and classifies them in a variety of ways that includes the use of Bloom's Taxonomy of Educational Objectives [2]. Combinations of the knowledge elements form learning units that in turn form the basis of courses of study in IS.

Using CSL our MSIS department has modelled the body of knowledge for Information Systems to make a formal link between professional requirements, our courses of study, individual papers, and our assessments.

Building a link between assessments and knowledge elements has many benefits; one is the student's ability to plot their progress in their studies over weeks, months, or years. In our design we retain students' achievement data with the result that we can provide a report on what parts of the body of knowledge the students have learned, what remains to be learned for a qualification, and what changes have occurred in the body of knowledge that were not available when they were taking their training. This latter feature should be useful for planning post-graduate sessions.

If post-graduate training or continued education is necessary then the differences between a student's personal accomplishments and their desired goal can be readily provided. In the case of obsolescent knowledge then the new knowledge elements are provided as links from the knowledge elements the student mastered earlier.

Under CSL students may wish to have their academic record stored at their former institution or at a central site and choose to query the system over the internet. If privacy is an issue an individual may store their academic record on their personal computer and then use the internet to compare their accomplishments with the current standards.

4 Learning through self- assessment

A dedication to life-long learning assumes the individual will be committed to continuous self-assessment. Many students have been put-off by their experience with "academic" tests and subsequent personal failure. Often failure was as much the failure to "read" the teacher as to read the book. Linking assessment with standards brings into the open the performance criteria expected and the conditions under which the assessment will be given. Under such systems students who often thought of themselves as failures find a new enthusiasm for learning. Learning can often be at the student's pace and assessments can be arranged when the student has practised enough to feel confident of success. The student feels less stress when the nature of the assessment, its conditions and timing can be controlled to some extent.

Assessment should not dictate curriculum or be unmanageable. It must be fit for the purpose. It should be a process linked to learning, not a separate entity. Its impact should have positive, not negative consequences for learning. [11]

CSL has been designed to support all known types of assessment ranging from on-line assessments involving multiple-choice, text, numeric, or pointing questions to data from off-line assessments such as "hands-on" evaluations. On-line assessment items may include multimedia such as graphics, still or moving video, and audio messages. Thus, the multimedia contribution could be anything from heart sounds to a short compressed video. CSL has been designed to make use of existing and future multimedia options on the internet or the client's system.

5. Past results

In it's first semester CSL provided 6000 on-line quizzes, and marked 1800 off-line tests for 1200+ students. It also supported a grade book and resource booking systems. Each student's quiz was selected from an item bank and matched the requirements set by the instructor. During a quiz the student could review all of the questions, answer them in any order they wished, change their minds, check the answers to be submitted and finally exit the quiz. Immediate feedback included a score and was followed by a detailed diagnostic message sent to the student by email. CSL was able to generate detailed feedback messages, for example, each answer option of a multiple-choice question could have a separate message. Precise remedial recommendations could be given if the author had the energy to write them. Every action the student performed on-line was stored - including if they changed their mind and when it happened. The diagnostic feedback for both on-line (weekly) quizzes and term's tests is generated through the data model that links course references and assessment items. The system has a high level of security, passwords can be provided that have a life span of less than a minute. If there is any technical failure during the quiz, CSL has always stored the student's last response.

CSL is now a much more sophisticated environment. Many forms of course management, assessment and feedback can be provided by the computer system (server). However, the end-user's experience will be governed by the strengths and limitations of HTML and the bandwidth available, Our preferred solutions, including JAVA, have provided quite a challenge due to differences among the browsers for the various platforms. These problems will be overcome with time. In the

meanwhile much useful material can be presented using the authoring tools available in such products as Office 97 and Netscape Gold. Media are prepared using QuickTime and Real Audio / Video. The IS'97 taxonomy has been prototyped in Hyperwave and represented graphically using HotSauce.

To date CSL has been used as part of the on-line learning strategy in Information Systems (five Papers) and Accountancy (two papers). An additional four papers use it in disseminating feedback or other administrative matters (some use it solely for booking terminals). In all 33 paper offerings have used it in the four semesters since its inception. In 1997 CSL was used by 4,959 of the 54,803 student-paper enrolments in Commerce and delivered 21,078 individual assessments. For the Database Management System paper this has comprised 3,390 assessments for both semesters of 1997.

6 Types of thinking skills and questions

Bloom [2] outlines the different types of thinking skills that may be tested. These are: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. It is possible to devise questions that test these different instructional objectives. They also state that multiple-choice items are considered to be the most effective of all the test items. Other examples of question types include: True-False, Matching, Fill-In, Essay and Problem. The primary disadvantage of multiple-choice is that they are the most difficult to construct. In particular it is difficult to construct enough suitable distractors. The Item Analysis report (Table 1) highlights the non-distractors (i.e. those options not chosen by questionnaire respondents). Generally the questions constructed followed the guidelines laid down by Ortiz and Lewis [12].

Some criticisms were raised as to the use of multiple-choice questions. People felt that they were only useful for testing knowledge and comprehension. One challenge then was to construct questions that tested higher order skills. To illustrate this, examples are taken from the bodies of knowledge for logical design and physical design. An example of each type of question answering skill is included in Appendix A. These questions were based on the course text "Modern Database Management" by McFadden and Hoffer [10], supplemented by case studies and other examples. 415 questions were prepared for the 1997 first semester Data Base Management Systems class taught to the BCom, BSc and BTech programmes at Auckland University's City and Tamaki campuses.

Table 1: Extract from Item Analysis Report

Which of the following is not a possible threat to the homestay business and FLASH system? (1 Mark)

No.	Option	Percent
1	Competition from other operators.	12%
2	Information is lost if the back-up fails	6%
3	Tourist boards reluctant to use the computer.	24%
4	None of these are potential threats.	0%
5 *	All of these are potential threats.	53%
	None	0%

Non-distractors: 4
Item discrimination ratio: 75%
Percentage of top 27% who got the question correct: 100%
Percentage of bottom 27% who got the question correct: 25%
Feedback for correct responses: Correct.
Feedback for incorrect responses: This is only one of the threats. There are many types of threats both external and internal to the system.

7. CSL quiz evaluation

The process was very much a learning curve for the teaching and CSL support staff as well as for the students involved - very few had used CSL in the Stage I paper the previous year. A range of multiple-choice questions were written to test all of the types of skills outlined in the previous section. This caused problems with the existing application. For example in some of the questions the stem, options and feedback messages were all longer than the 256 character strings initially supported. A current limitation is the maximum string lenght of 50 characters for text variables. In addition text variables are not shared across questions or references. Some questions required formatting which either had to been incorporated into the CSL application or could not be supported. Examples of the former included the use of variables, of the latter - the use of figures and tables. Overall, across the campuses and semesters, between 77% and 86% of those still enrolled at the time of the final exam sat the quizzes. However it is not possible to make an independent statement on the effectiveness of the quizzes as a learning tool.

In contrast with other papers, the database students could sit the tests at any time in the week at their own convenience. Provision was made for them to access the quizzes from external terminals. They could use their text books and any other appropriate form of assistance.

Item Analysis was performed on the completion of each test. Particular note was taken of the individual item's difficulty, the Item Discrimination Ratio (IDR) and the distractors chosen by the students. (IDR is calculated from the difference between the top 27% and bottom 27%

of students who got that particular question correct. The top and bottom groups were formed based on the students' overall performance in the quiz.) The item's difficulty and distractors were used as feedback by the course instructors to remedy problems encountered by the students and the IDR to examine questions where a negative score suggested that the item needed improving.

As a result of the response obtained from the students surveyed (see the next section) the feedback messages for incorrect answers (distractors) were improved. In order to improve the migration to a different text book (in 1998) the questions were made more generic. Individual questions too were improved. Where analysis of the results (using the Item Analysis program) indicated questions caused difficulty - either by having a low score or a negative discrimination coefficient - they were rewritten. For example, in one instance a question with a negative discrimination coefficient was altered by appending an instruction to the students: "Think about it - the answer is not as simple as it might seem to be." This resulted in a increased score for it in the second semester and a positive discrimination coefficient.

8. Evaluation of CSL and its interface

At the end of the first semester a voluntary questionnaire was administered to the class. This was repeated in the second semester (the comparable results are given in brackets). Twenty-nine students responded to the questionnaire which was itself administered as a CSL test (and a further 109 in the second). The questionnaire examined two aspects. First, the interface design of CSL and second, the value that the students placed on using the CSL quizzes to prepare for the course's overall assessment. The results have been summarised as follows:

1. Approximately 7% (13%) always used CSL from home while approximately 17% (65%) accessed it from home at some time.
2. Ninety-seven percent (90%) said the first time they used CSL it was very easy, easy, or OK. This positive response grew with successive uses. Only 3% (1%) thought the interface was bad
3. The only question where CSL did not score highly was in the usefulness of its error messages. Slightly more than 50% (62%) of the people found the feedback messages useful.
4. Ninety percent (85%) indicated that they would use CSL as a study aid even if there was no credit given for the practice! Ninety-seven (89%) percent would use CSL to look at their marks in other papers and 67% (71%) would like to take CSL tests for their other papers.

In general the students were happy with the interface, would sit voluntary tests (i.e. those not contributing toward their final grade) and considered the process to be advantageous. They felt that more detailed feedback was required as to the results of the individual questions. To some extent the feedback was improved in the second semester items.

It should be remembered, however, that there was initially only a 24% (42%) response rate to the questionnaire. Although this is higher response rate than that usually recorded by mail surveys, it still represents only 29 opinions from a class of 121 first semester students but a respectable 42% from the second. Nonetheless we remain optimistic about our findings. The initial response rate was low, but the responses were encouraging and provided a basis from which the process of improving the CSL approach was continued in the second semester and subsequently over the summer.

9. Case studies

In 1995 ten case studies were devised and used to teach the first year Information System courses [13]. These were presented during weekly tutorials. Students were examined on them using a combination of multiple choice and short answer questions during the tutorials and short essays in the final exam. At present 211 multiple choice questions have been written based on these quizzes and made available through CSL (Table 2).

Table 2. CSL questions based on case studies

Case	Count
Bungy	20
Flash	19
Instant Insurance and Kwik Klaim	19
Kuala Lumber	23
Open All Hours	18
Power Saver	26
The A Team	20
Tripro Engineering	23
The Auckland Warriors	23
William Ellison	14
Total	**211**

The classes of artefacts present in case studies were modelled in the ERWIN case tool. This allowed the questions to be cloned from the initial case. Using variables in both the question stems and multiple choice options has effectively increased the variability in the questions. This mitigates against the tendency of students in collaborating to 'learn the answers'. The quizzes based on these cases are as yet untested on the types of classes they were designed to facilitate. With the change to semesters, the cases and tutorials were dropped from the course schedule. They may be used if an Information Systems paper is taught as a service course to Arts students. A CSL evaluation quiz would be run at the completion of the exercise.

We would also like to internationalise the use of these cases by making them available to other organisations and to extend the range of cases available. The quizzes are available at the following web site: http://cecil.msis.auckland.ac.nz/Session/csllogin.asp and the IDs and passwords required to run the quiizes can be obtained by contacting the authors.

10. Enhancements

Several enhancements have been started or planned. These will extend the use of CSL to other courses.

10.1. Template marking sheets

Marking sheets were devised to use in the Stage II and III Systems Analysis and Design courses. These allowed the assignment setter to compose a list of features expected in each answer. A weight can be established for each feature and the assignment graded by giving a mark for each point. Thus each assignment is graded and the students can receive feedback messages advising them of areas of weakness. The advantages of this approach include: uniformity of marking, fairness of the marking system, automatic entry of marks in gradebook, remedial feedback for the students and detailed analysis of the results by the examiners.

10.2. Questionnaires

CSL can be adapted to analyse questionnaires entered either real-time by the subjects or from paper-based forms at a later stage. Indeed, the former was the approach used to analyse the CSL interface. At present references are tied to courses and sign-ons to enrolments. CSL is being rewritten to allow more flexibility in this regard. This will open up access to the database to anyone with Internet access provided that they have the appropriate session passwords. The respondent's anonymity can be guaranteed if this is required.

10.3. Advanced questions

At present the variables available to be used in CSL are either text variables or mathematical expressions that can be evaluated using Excel. Other than in physical design, there are few opportunities available in Infomration Systems to use the latter, however they are extensively used in the Acounting papers. It is hoped to create a SQL interface to increase the range of questions available. This will have a twofold benefit. The range of question (options) will be increased and questions will be able to be set on SQL syntax and evaluation.

The initial 415 questions are being augmented from other sources including the more recent edition of Rob and Coronel to be used in 1998 [14].

10. Other approaches

Other organisations have used alternative web-based strategies for managing distance education. For instance, LODGEiT is used at Southern Cross University for assignment management. Assignments can be submitted, marked and feedback provided via the Internet [3]. The project authors summarised that such a system offered the advantages of being cost-effective, secure, having a fast response, human-resource efficient and paper-less. As can be seen from the previous discussion CSL too offers these advantages. These points assume importance as we redefine the role of the University in disseminating knowledge.

11. Conclusion

We believe computer supported learning, easily accessed through the internet, can provide useful assistance to our community. CSL may become one of the means by which the university reaches out to its constituency to fulfil its mission. Universities create, organise, store, disseminate, and assess knowledge. Our computer systems can be designed to intelligently deliver our traditional services; and, if permitted, to acquire, analyse and model groups or individual's learning achievements. Academics will not be replaced but their role as a guide and a resource will be emphasised.

Institutions that place their bodies of knowledge, curriculum and their assessments in the public domain will persuade New Zealanders that they are progressive, goal-oriented and successful - a necessity to maintain the competitive-edge in the global marketplace?

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Appendix A: Example Questions illustrating the Types of Thinking Skills that may be addressed

Skill Type	Question Stem	Correct Option
Knowledge	The _____ database model represents data in the form of tables.	relational
Comprehension	An attribute that appears as a non-key attribute in one relation (ie does not form part of the Primary Key), and as a primary key attribute in another relation is:	a foreign key
Application	The primary key of the relation STARTING LINE-UP is a composite key consisting of the three attributes TEAM NAME, GAME NUMBER and POSITION NUMBER. The attribute POSITION NAME in this relation is functionally dependent on POSITION NUMBER. This is an example of:	a partial functional dependency.
Analysis	The following two relations were developed from two different E-R diagrams. The Primary Keys are designated thus (PK):DESPATCH (DESPATCH-NUMBER (PK) , DESPATCH-DATE , DESPATCH-ADDRESS)INVOICE (DESPATCH-NUMBER (PK) , INVOICE-DATE , INVOICE-AMOUNT)The process of integrating these relations would result in:	a single new relation with DESPATCH-NUMBER as the primary key and three non-key attribute fields: DESPATCH-DATE, DESPATCH-ADDRESS, INVOICE-AMOUNT.
Synthesis	Consider the two following tables: PAPER Paper_nbr Paper_name Instructor_id 222 DBMS 100 232 IS Mgmt200 322 SE II 400 320 Analysis II 100 FACULTY Instructor_id Instructor_name 100 White 101 Black 102 Orange 103 Puce Which of the following insertion requests should be refused?	321 IS Project 500
Evaluation	Considering the following SQL statement: SELECT Order_nbr, Item_Code, Order_date, Quantity, Sum (Price*Quantity) FROM Order_line WHERE Date>01/05/97 GROUP BY Item_Code Which attributes would be most suited as keys to improve the efficiency of the query?	Item_code, Order_date

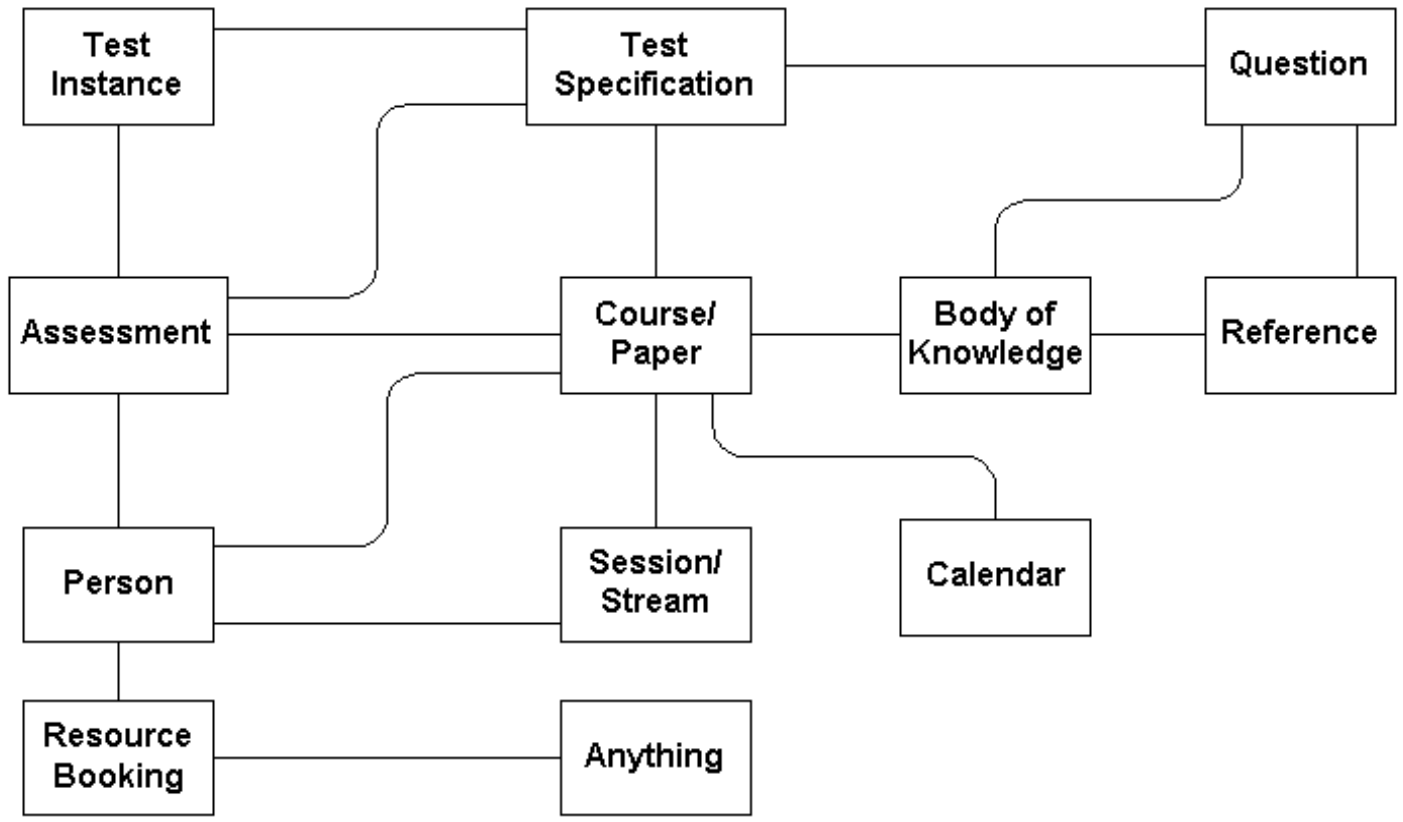

Figure 1: Computer Supported Learning: A Model