Mathematics Delivery using Online Distributed Learning Systems at RMIT

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Abstract

Distributed Learning Systems (DLS's) provide the opportunity to enhance the delivery of mathematics subjects using a variety of web-based tools that permit both staff-student and student-student interaction. Within the two main DLS's currently being benchmarked at RMIT, the tools available include: email, discussion lists, virtual chat, web-based shared workspace, joint document storage facilities, Maple and a variety of testing and survey capabilities. From a mathematics point of view most of the available generic testing tools are of limited use, but Weblearn — a product developed at RMIT — is an exception.

In this paper I will describe the two main systems (Serf and Online@RMIT) currently being used by the mathematics department at RMIT, and how the available tools are used to support the delivery of mathematics subjects from within these systems. In particular, I will describe the student-centred testing and feedback capabilities of the package Weblearn; explain how we are currently using Weblearn to distribute drill and diagnostic questions in several of the large-enrolment first year subjects at RMIT; provide examples of how the mathematics department has commenced using the DLS's in their teaching programmes; and anticipate how we plan to use such DLS's in the future.

1 Introduction

The main characteristics of DLS's are their networked nature and their use of the Internet and web technology, together with appropriate applications,

to provide access to workspaces and learning resources via a web browser. Two DLS's that are being trialled by the mathematics department for the remote delivery of some of their subjects are Serf (server-side educational records facilitator) and Online@RMIT. Of these, Serf is the product that had been selected for the delivery of all of RMIT's contributions to the Open Learning Australia (OLA) project, whilst Online@RMIT is being developed by the DLS team within the Information Technology Alignment Programme (ITAP) at RMIT to deliver subjects that do not necessarily form part of the OLA project. A major driving force behind the introduction of these systems is to enable information sharing, collaboration and communication amongst students and between staff and students in a flexible mode that allows their learning to extend beyond the usual classroom mode.

Although Serf has an inbuilt testing component, the mathematics department's SEM course team have adopted Weblearn as its preferred testing package. Consequently, whenever a quiz or test is required within a subject offered by Serf, a link to the Weblearn system is provided. Online@RMIT offers Weblearn as one of the testing and learning programs that form part of its DLS.

Tools with similar features to those appearing in the DLS have been available separately for some time, see for example [1]. However, it is their integration into one over-arching system, together with the underlying database compatibility, which is the significant step forward. Such systems allow students to study complete subjects online either off-campus (using their own Internet Service Provider (ISP)) or supporting on-campus activities (using available computer laboratories).

2 Discussion

2.1 Weblearn

WebLearn was developed by the Distributed Computing Research Group within the Department of Computer Science at RMIT under the leadership of George Fernandez and continues to be enhanced as a major tool to support teaching and learning at RMIT. It supports self-learning by providing automated feedback via quizzes and tests with electronically submitted answers being marked electronically. This tool is used by students to monitor their own understanding of each topic, and by teaching staff to formally test and record the assessment details of students.

Weblearn is a suite of underlying database tools that supports the collec-

tion of information relating to particular questions attempted, success rates on any particular question and the maintenance of results of all forms of assessment submitted by each student. Furthermore, within each subject, tutor-specific support levels can be created and assigned certain "rights" that allow them to interact with the basic system. For example, students can then electronically select to be part of a tutorial group (if it has not yet reached its quota), move from one group to another, and submit files as part of their assessment to their particular tutors drop-box etc. The mathematics department at RMIT is using this last facility to allow students to submit Maple worksheets for tutor marking rather than the students submitting a printed version as they did previously. This obviates the need to keep detailed records of when material is submitted by each student, allows students to present viewable animations as part of any assignment, and from an environmental point of view reduces paper usage.

Within Weblearn, a quiz is defined as a set of questions designed to provide an immediate response to students, usually on their understanding of a single learning objective. This provides an ideal environment for the testing of basic skills of the "drill" type. On the other hand, a test is defined as a set of questions (which may be the same as those created for a quiz) that is submitted for assessment purposes. Unlike for a quiz, marking of these tests is not immediate. Once a test has been marked, a web page displays the question they were asked, their response, whether they were correct or not and how many marks were allocated to that particular question. At any time during the running of the subject, students can access this information for any of the tests that they submit.

The structure of each question bank is well devised, consisting of questions that allow for divisions based on the concepts of a "module", an "objective" and a "question". Based on this hierarchy, quizzes and tests can then be configured by the instructor to randomly choose a specified number of questions from each objective within each module. Furthermore, each question may be of two main types. These are referred to as either of the "static" or the "dynamic" type. A static question has any of the parameters of a question "hard-wired" into the question, whereas, in a dynamic question, one or more of the parameters appearing in a question will be chosen randomly by Weblearn from either a defined list of nominated values or else from within a user specified range. If a question is multiple choice, then Weblearn can be configured to display these choices in a different order each time that question is presented. Use of the dynamic type questions simplifies considerably the creation of questions that will be unique for each student who attempts a given quiz or test from a specified module bank. These features help to

overcome some students attempt to "learn the answers" to a range of typical questions.

Banks of questions, in the form of cropped pdf files, have been generated that are then pasted into the form that presents the quiz or test to the student. These questions are of the static form and are either of the true/false or multiple choice type. The answer (or answers) to these sets of questions are then selected by using standard radio buttons, checkboxes etc., and the quiz or test submitted in the usual fashion. The Science and Engineering Mathematics (SEM) course team at RMIT have been successfully using Weblearn since the beginning of 1999 for subjects including basic first year calculus and second-year level differential equations. Both these subjects involve large enrolments of approximately 1,200 and 250 students for the year-long calculus subjects offered to the Faculties of Engineering and Applied Science respectively, and from 800 in the differential equations course.

Recently, the SEM course team has been experimenting jointly with the Weblearn development team in employing Maple as a back-end to Weblearn, so that the power of Maple can be used to check the students' answers to Maple generated questions. With this facility in place, questions in Weblearn can be created as the dynamic type with the random content of any question, and the student's response, fed to Maple for verification of correctness. This information is then returned to Weblearn which invokes any necessary record-keeping database functions and feeds back the relevant response to the student. This technique is currently being trialled. The Weblearn/Maple interface is robust, and appears to successfully address the testing of basic mathematical principles. We are currently monitoring this innovation in the SEM course team's approach to teaching and learning and will instigate an appropriate evaluation phase at the completion of the subject. Experience gained so far using this Weblearn/Maple interface is providing the impetus to use features within Maple to refine appropriate responses for return to the student and based on their level of comprehension of the teaching objective. This strategy for providing useful student feedback is also under development elsewhere, see for example the URL:

`http://CalMaeth.maths.uwa.edu.au/doc/overview.html`

2.2 Serf

Serf is a web-based distance education environment developed at the University of Delaware and authored by Fred Hofstetter. It provides an environment for delivering courses using the World Wide Web as a distance education medium. In Serf, each subject consists of the combination of a roster, a

syllabus, a calendar and a chosen presentation style. The calendar is the driving component of Serf and provides dates for the instructional events on a syllabus. Serf makes it possible to create and deliver courses in a self-paced multimedia learning environment that enables students to navigate a syllabus, access instructional resources, communicate and submit assignments over the Web. Students' assignments are easily accessible and graded via the Serf gradebook, although, for mathematics delivery at RMIT, Weblearn is used instead for this activity. At any time, students can access a report of their progress in a subject, along with comments from their instructor and a prediction of their final grade.

A course is created within Serf with a Web-based syllabus editor that comes as part of the distribution. The editor allows insertion, editing, moving and deleting of events on the syllabus. All of the HTML is generated automatically within Serf. (Customization of Serf screens can nevertheless be achieved using HTML.)

Dr. Graham Clarke of the SEM course team in the mathematics department at RMIT, is developing the OLA subject MAT17 using Serf. This subject is an introductory course on discrete mathematics, the content of which is equivalent to material that forms part of the compulsory component of the first year of the Computer Science degree offered at RMIT. Graham had no previous experience in using either the web or in writing HTML code before embarking on this project. Nevertheless, following a few general discussions on the philosophy behind Serf and how the web works with other members of the SEM course team, he was easily able to produce the online lectures needed for the delivery of MAT17 using Serf.

The content of the subject MAT17 is delivered using pdf files with embedded hot links to Weblearn quizzes and tests. These quizzes and tests form an integral part of the teaching, learning and assessment aspects of the subject. The SEM course team are currently monitoring the development, presentation and student response to the delivery of this subject. When this subject is completed in September 1999, the SEM course team will evaluate the effectiveness of this method of delivering the subject's content, the overall performance of Serf as an example of a DLS and what other features of Serf might usefully contribute to enhancing the presentation and improving the learning capabilities of MAT17 online.

2.3 Online@RMIT

Online@RMIT describes a variety of teaching and learning approaches, the tools and/or associated applications, the networked systems, the standards

and the supported infrastructure that characterise RMIT's developing Distributed Learning Environment. It is under development by the DLS group, within ITAP, as part of RMIT's recognition of the need to provide students and staff with the means to access and participate in the learning process in a more flexible way. RMIT's commitment to this aspect of student-centred learning recognises that opportunities for learning are not necessarily limited to the classroom or lecture theatre, and that Information Technology, used in an appropriate and well-structured manner, can improve the accessibility to teaching materials by all students.

The tools and applications that form part of Online@RMIT have been organised around four main "metaphors" — a Campus element, a Classroom element, a Conference element, and a Collaboratory element. The suite of tools and applications underlying these four metaphors have been customised to share the same databases, navigational features and network security systems; it thus removes the need for multiple logins and provides a seamless integrated environment that supports the teaching and learning process. It is planned that RMIT's newly developed Student Management System will interface directly with the Campus element of the DLS via an Oracle database.

The Campus element is the main area that links students to the other elements of the DLS and to other supporting subject-specific web-based applications such as Weblearn. The Classroom element provides the opportunity to augment any face-to-face teaching and learning activities by establishing an online presence. Individual instructors can produce the material that forms this presence using a series of available HTML templates and a small number of useful wizards. Each such electronic classroom may contain links to other World-Wide Web resources, both asynchronous and synchronous communications, a course calendar, and access to their results. The Collaboratory element is predominantly a shared workspace, storage facility and meeting area that groups of students, for example, can use for the effective management and development of joint activities. This space should be particularly attractive to the large group of students who are enrolled part-time and may otherwise find it difficult to meet regularly with colleagues on campus, and also to facilitate discussions between students studying on the various campuses of RMIT that are separated geographically.

A complete description of the DLS Online@RMIT can be found by following the variety of links embedded in the web page located at the URL:

`http://www.online.rmit.edu.au/`

Details of the tools and applications can be found by choosing the link "Community" on this page (and then following the sequence of links "Resources"

and "DLS Toolsets" on successive pages).

The author of this paper, together with Dr. Serdar Boztas of the SEM course team, is trialling this DLS using as a pilot a second year differential equations subject offered to the Faculty of Engineering. The enrolment in this subject for second semester is approximately 200 students. The content of the subject is delivered using pdf files with embedded hot links to Maple worksheets, Weblearn quizzes and tests. These Maple worksheets, and Weblearn quizzes and tests form an integral part of the teaching, learning and assessment aspects of the subject. The mechanism for the submission of the Maple assignments will be via the Weblearn feature of uploading their completed Maple worksheet directly into their designated tutor's drop-box. The majority of the Weblearn quizzes and tests will use the Weblearn/Maple interface. The SEM course team are currently monitoring the development, presentation and student response to the delivery of this subject as well as the newly developed interface between Weblearn and Maple. When this subject is completed in November 1999, the SEM course team will evaluate the effectiveness of the method of delivering the subject's content, the overall performance of Online@RMIT as an example of a DLS and what other features of Online@RMIT might usefully contribute to enhancing the presentation and improving the learning capabilities of this subject online. Of special interest will be how to exploit the flexibility of both Maple and Weblearn to improve the response to students on selected tasks, in particular in providing positive feedback to students' answers that are only partially correct.

3 Future Directions

The SEM course team are currently reflecting upon how to effectively use some of the other features of the two DLS's that have as yet not been exploited in the mathematical context. One of the main reasons for this lack of exploitation is that text-based communication tools are not conducive to the transmission of mathematical content. However, two possibilities present themselves. (1) To use the synchronous whiteboard features for (mostly) one-to-one discussions. This would only seem to be viable for small enrolment subjects. (2) To explore the use of snippets of Maple code, whether or not it is embedded in an appropriate worksheet, to facilitate mathematical dialogue between students and staff.

The other main activity for further work is to explore the Maple/Weblearn link in providing a powerful and effective tool in improving the teaching and learning of mathematics at RMIT.

References

[1] G. F. Fitz-Gerald, W. P. Healy, and M. Lukic. Internet Course Material Supporting Mathematics Programmes Offered at RMIT. In Wei-Chi Yang, Kiyoshi Shirayanagi, Sung-Chi Chu, and Gary Fitz-Gerald, editors, *Proceedings of the Third Asian Technology Conference in Mathematics*, pages 122–131, Singapore, August 1998. Springer.