COMBINING OFF-LINE AND ON-LINE ASSESSMENT FOR DISTRIBUTED LEARNING

Paul Rowley
Adam Crawford, Bee Lin Goh and Richard Goodman

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Dr Paul Rowley
CREST (Centre for Renewable Energy Systems Technology)

Dr Adam Crawford and Ms Bee Lin Goh
Eng TLSC (Engineering Teaching and Learning Support Centre)

Mr Richard Goodman
Computing Services

Loughborough University
Leicestershire
LE11 3TU

Tel: +44 (0)1509 228138
Fax: +44 (0)1509 610031
E.mail: p.n.rowley@lboro.ac.uk
http://crestdl.lboro.ac.uk

Abstract

As part of a new programme for flexible and distance learning, CREST, Eng TLSC and the Department. of Computing Services at Loughborough University have developed a series of Continuing Professional Development Units in Renewable Energy Systems Technology. Over 70 students employed by SMEs (small and medium-sized enterprises) across the UK participated in the inaugural course (March-June 2001).

The course utilised a hybrid CD-ROM/WWW/SMTP learning and teaching approach. Summative and formative assessment was performed off-line via the course's learning support CD-ROM (due in part to issues connected with learners' Internet access). Student's answer files were then uploaded to the University's secure 'CRESTDL@Learn' WWW server for tutor marking and data evaluation.

This paper describes the strategic and technical development of the work, along with practical aspects of its implementation. Specific areas explored include:

- CAA issues for distributed learners;
- Baseline data and pre-evaluation;
- Design of individual assessment profiles for industry-based learners;
- Development of the hybrid WWW/CD assessment system;

- Determining the CAA question protocols;
- Student and staff evaluation of the system;
- Advantages of the system when marketing the courses in the corporate sector.

The results indicate that such a 'hybrid' approach can provide students with effective access to a complete virtual learning environment, without an Internet connection being a pre-requisite. Such an "anytime, anyplace" system may be integrated with a Web-based tutorial support infrastructure to provide a full range of VLE tools.

Key words

Formative assessment, summative assessment, virtual learning environment (VLE), learning management system (LMS), continuing professional development (CPD), distance learning)

Introduction

Education providers worldwide are increasingly looking to distributed (or distance) learning to complement their on-campus programmes, and E-learning courses (those utilising computer-aided and Internet or WWW-based tools) are proliferating. In the engineering sector where ‘hands-on’ experience has been a key feature, this raises issues related to the overall quality of the learning and teaching experience.

As early as the 1930s, studies have shown that assessment results for distance learning students have been comparable with on-campus learners (Sorenson, 1936). Computer mediated or WWW-based offerings have been shown to be as effective in terms of students' learning outcomes as traditional lecture-based courses (Barry, 1995; Moore, 1996), but little research has been carried out in the engineering education sector (Lloyd, 1996).

A number of engineering-specific assessment environments have been developed, and in the case of renewable energy technology, a small number of Centres have developed on-line and computer mediated courses (Rowley, 1996; Rowley 1997; Lund, 1997). Building upon this experience, the Centre for Renewable Energy Systems Technology (CREST) is currently developing a range of courses based on its current MSc programme. This develops recent and current work including:

- An EU-supported programme to evaluate the training needs of the UK renewable energy industry, and to develop pilot professional development distributed learning units and
- A UK government-supported project to convert CREST's existing full-time campus-based MSc programme to flexible block taught, distance learning and part-time format.

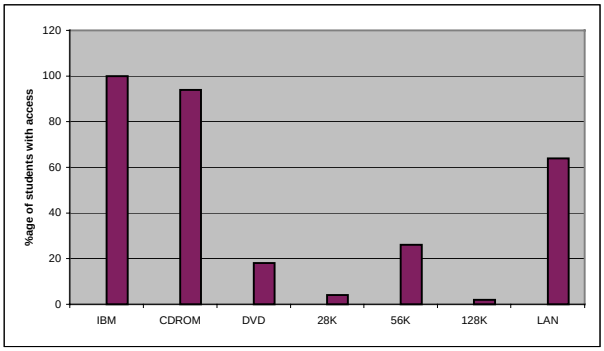
In particular, the new range of courses are being designed with the needs of employees within small to medium sized companies in mind.

The Virtual Learning Environment (VLE)

Baseline research

It is important that the conflict between the need to deliver media-rich learning experiences and limitations on clients' Internet bandwidth and connectivity is recognised and addressed appropriately. This applies to delivery of an effective assessment framework as well as to core learning and teaching content.

Fig 1: IT facilities and Internet connections within UK renewable energy SMEs



An initial analysis of Internet and IT facilities was undertaken within the UK renewable energy industrial sector. The results are summarised in fig 1 (right). The results indicate that of the 73 individuals surveyed, approximately 62% had LAN access to the Internet, and around 25% utilsed a 56kBps connection. All users surveyed used IBM PC compatible machines in the workplace.

VLE technologies

Based on the above data, (especially in light of the bandwidth and connectivity limitations of a number of our clients), the pilot training programmes were designed using a hybrid Internet/CD-ROM approach, in which a VLE on the CD-ROM is linked to the WWW for uploading and downloading of files and for peer-to-peer and student-tutor communication. This approach effectively:

- Provides functionality of a web based learning environment
- Produces a personalised learning programme, incorporating a wide variety of computer based learning resources, which conform wherever possible to current IMS guidelines.
- Reduces time spent online which in turn: reduces dependency on the phone company and internet service provider, reduces costs for the learner and saves download time,
- Provides a tested robust delivery mechanism and reduces software specific problems such as necessity for specific versions of browsers, plug-ins and operating systems

The off-line CAL tools in the current CRESTDL virtual learning environment incorporate a range of computer aided learning (CAL) applications (such as Authorware-based simulations, image-based and multi-choice assessment tasks, study notes and case studies within a structured (and guided) learning management system. During navigation, an automatic record is taken of students' progress through the learning environment, which may be referred to by the student as a means of tracking progress. The student negotiates each module via a number of "learning segments", each designed to be completed in 1-2 hours. This format suits the time constraints of work-based participants, where learning typically takes place over similar periods. The materials are developed utilising generic structures and frameworks. This means that we can easily change the look and feel of the overall package to maintain a consistent image and brand without affecting content.

Assessment Methods

In this paper, we will focus on the assessment methods used during the pilot programme, in which a large cohort of Industry based Continuing Professional Development Students participated.

Training needs assessment

In many cases, work-based students require support in assessing their training and education requirements. Specific examples include:

- New employees
- Existing employees who do not have a defined job specification
- Employees in the process of changing roles
- Employees engaged in activities spanning a number of disciplines

In addition to defining subject areas, students may also need support in realistically assessing the amount of time they can devote to study over a given period. In light of these issues, prospective CRESTDL students engage in consultation with their line management to define subject areas in which training is required, and to negotiate a work-based "study schedule". This data is then analysed at CREST, and a "recommended study profile" is constructed for each student, based on their available time and required subject areas.

Formative assessment

Each Study Unit on CRESTDL CDROM contains a range of formative assessment tools. An environment has been developed using Macromedia Authorwaresoftware, where the questions are integrated into the student's study programme at defined intervals. The assessment tools include:

- ***Multiple choice/multiple response and "Drag and drop" style questions***.

These can be set so that the student must complete the question correctly before progressing. To ensure the student is made aware of the correct solution, the questions are visually marked on screen after the correct response(s) has been input. For multiple response questions, where there are a wide range of answer permutations, the maximum number of attempts is set (typically to 4) to prevent the learner from adopting a lengthy and frustrating trial and error approach. These questions can also incorporate question-specific feedback for wrong answers, giving them pointers to why it is the wrong solution (such as checking the units or magnitude). It is also possible for the student to track back through the test and review the correct solutions for previous answers.

Fig 2: 'Drag and drop' self assessment applet

An overall test score is assigned based upon the student's first answer to each question. Fig 2 shows an example of a 'drag and drop' applet.

A vital feature of the formative assessment tool set is that the first answers to each question from a particular test are encrypted and saved to disk, with the file name constructed from the students log-in ID, test type and identifier. This file is then uploaded to the secure 'Learn' server and used by the tutor to monitor progress or to track the effectiveness of individual questions for future modification and updating of the test question bank.

- ***Self assessment simulations.***

A range of simulation applets are integrated in the CRESTDL VLE. These illustrate more complex aspects of the subject material, and are based around an initial "storyboard". Each simulation contains a number of assessment steps, each of which must be negotiated successfully before moving on. The example here (fig 3) illustrates one such simulation, in which different technology aspects related to the energy production of a solar electric system are explored. The increased complexity (and cost) of these simulations means that their production must be selective and targeted to specific areas of the learning programme.

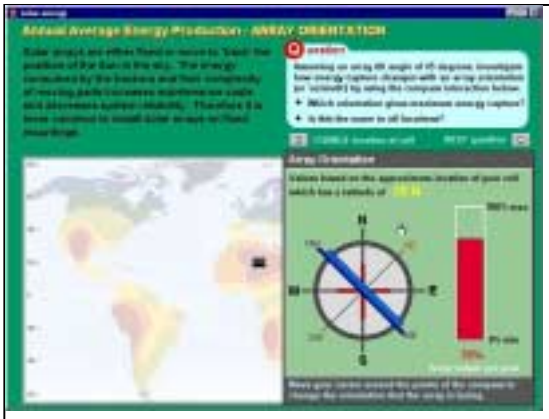


Fig 3: *Self assessment E-Learning simulation package*

Summative Assessment

In addition to the question types described above, each Study Unit within the CRESTDL VLE also incorporates a series of "short response questions", which require text input by the student (typically of about 400 words). On completion, the student's answers are encrypted and written to a specified location on the student's computer. At a convenient time and location to the user, these response files are uploaded to the secure Loughborough University Learn web server for marking by the module tutors. This system is described in detail below.

Alignment with technical standards

It is important that all new CAA applications allow interoperability with other applications. IMS is a consortium brought together to write specifications for distributed learning, and the list below indicates the how components within the CRESTDL VLE align with IMS specifications for computer aided learning materials:

Issues	CRESTDL
Assessment level support	Yes
Section level support	Yes
Objectives & rubric	Yes
Flow	Yes
Material content	
Text	Yes
Emphasized text	Yes
Image	Yes
Video	No (to be developed during 2001)
Audio	No (to be developed during 2001)

IMS also addresses QTI (Question & Test Interoperability) specification recommending a format for standardising computer aided assessment. It is interesting to note the features listed there and compare them with what CrestDL have. Below is a summary:

Question types detailed in IMS	CRESTDL
Multiple choice	Yes
Multiple response	Yes
Drag and drop	Yes
Short answer	Yes
Fill in the blank	No
Numeric	No
Image hot spot	No
Other related areas	
Response processing	Yes
Feedback	Yes
Hints & solutions	Yes

The on-line learning and teaching environment

For some time, Loughborough University has been developing its intra and internet-based learning management system. This system, named 'Learn', was established to meet two perceived needs:

- To promote more efficient and effective communication between staff and students, and make it possible for students to support each other's learning and contribute to support for modules
- To develop online Teaching and Learning at Loughborough University, both locally and via distance learning.

Table 1 below shows data on the increasing usage of the 'Learn' LMS.

Table 1: Number of successful hits on the 'Learn Server' covering the first month of the relevant academic years.

Period of operation	Number of modules	Modules with resources	Number of hits	Total amount of data transferred (Gigabytes)	Average data transferred per day (Megabytes)
October 1999	2910	218	272,571	2.58	94.36
October 2000	2824	415	682,784	6.74	246.39

From an early stage, the on-line components of CRESTDL were integrated into this system, and acted as a catalyst to the extensive development of the 'Learn' environment.

Tutorial support and feedback

It is vital that students receive rapid feedback upon submission of assignments, especially when dealing with corporate clients who utilise "just in time" learning techniques. CRESTDL's colour-coded system (Fig 4 below) in combination with an 'auto-email' notification system, ensures that tutors are warned when marking/feedback for specific submissions is overdue. This LMS has been developed specifically for the corporate sector, (where ease of use and rapid tutor feedback is essential) in light of the team's extensive experience with other LMS packages (such as Top Class and WebCT) and in view of student and tutor evaluations.

Feedback from use of this system has resulted in enhancements and modifications including a simplified interface, clearer navigation between questions, tracking of completed tests and the ability for the student to save and retrieve answers before (and after) submission. A log of students' progress through the WWW-based CRESTDL LMS is also recorded and may be referred to at any time by the course administrator or tutors to track individual progress.

Staffing issues

The recruitment of high-quality tutorial support will become increasingly important as the programme develops and student numbers expand. Therefore, CREST are developing a network of on-line tutors with expertise in appropriate areas. This network

includes both internal and external personnel, and will grow with the programme. A number of national and overseas institutions involved in renewable energy education and training have expressed interest in this concept.

Future work

This work forms the basis for conversion of CREST's existing MSc in Renewable Energy Systems Technology to modular distance learning delivery, starting in October 2001. In addition, a full range of Continuing Professional Development courses will be launched on a commercial basis.

Possible future e-learning tools to be integrated include automatic mobile phone text messaging, whereby students are notified when tutors have marked specific assignments. As the technology develops, mobile access to tutor feedback via WWW-enabled portable handsets will also be evaluated.

Conclusions

1. A 'hybrid' on-line/CDROM approach can overcome Internet bandwidth/connectivity limitations, and provide students with effective access to a complete virtual learning environment.
2. Student access to highly interactive learning applications can be enhanced if delivered on CDROM rather than via current Internet technologies
3. Such an "anytime, anyplace" system may be integrated with a Web-based tutor-supported learning management system to provide a full range of VLE tools.
4. An effectively designed and managed system can provide the corporate sector with effective "just in time" tutor-supported training without overloading teaching staff.
5. The development of a wide network of quality-assured on-line tutors can reduce the support workload of internal core teaching staff.

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