LTDI
Evaluation Studies

Learning Technology Dissemination Initiative

Edited by Nora Mogey
With the help of other members of the LTDI team

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Preface

The Learning Technology Dissemination Initiative was established by The Scottish Higher Education Funding Council in August 1994. Since then it has been working with departments and individual academic staff to assist with the effective use of technology to enhance the learning environment.

Although it is now not unusual for learning technology to be seen as a core component of many courses, there continues to be a need for research about whether technology makes an effective and positive contribution to the learning experience for students. Hence as part of its programme of activities, LTDI has been working closely with a small number of projects in Scottish Universities, to support the evaluation of their existing use of computer based learning materials. The results of some of these projects are presented in this publication along with some papers from the one day conference 'VALUE':- Views Activities and Learning: Understanding Evaluation, which was hosted by LTDI in May 1998.

This collection is therefore varied, both in style and content, and we hope that it will make interesting and thought provoking reading. Much of the work described is ongoing and the results presented are in that sense only interim. All the papers include suggestions, comments and experiences which can be transferable to other disciplines. Where possible original data has been included so that the reader may draw his own conclusions from the evidence collected.

These Evaluation Case Studies are complemented by the LTDI Evaluation Cookbook, which is a practical guide to evaluation strategies and techniques. All LTDI publications are also accessible from the LTDI World Wide Web site
http://www.icbl.hw.ac.uk/ltdi/ltdi-pub.htm

Finally we would like to thank all the authors who have contributed articles and papers for this publication, without whom this collection would certainly not have been possible.

LTDI Evaluation Studies: Contents

Chapters 1, 2, 4, 5, 7 & 8 were presented as papers at 'VALUE Views Activities and Learning: Understanding Evaluation', a one-day conference held in Edinburgh on Wednesday 13th May 1998

How to Add - VALUE

Kirsty Davidson & Judy Goldfinch, Napier University

Abstract

Over the last few years there has been a very rapid advancement in the development of communication and information technologies. These developments have been both in hardware and supporting infrastructure as well as in software.

The Scottish Universities are fortunate in having broad bandwidth ATM connecting networks which can be used for video conferencing and transferring large amounts of data. The importance of exploiting these Metropolitan Area Networks (MANs) was recognised by SHEFC and various projects were funded under the Use of the MANs Initiative. This paper reports on one of these projects called SUMSMAN (Scottish Universities Maths and Statistics over the Metropolitan Area Networks).

The main aim of the SUMSMAN project is to exploit the potential of the MANs to deliver an integrated programme including multimedia courseware and interactive learning experiences. A report will be given of the problems and achievements found in trying to encourage universities around Scotland to integrate multimedia courseware into their teaching. Views from both staff and students involved in using courseware will be described. A range of evaluation tools are being trialed. These include questionnaires, observation, focus groups and confidence logs. Pre and post tests have been used to attempt to assess the effectiveness of the courseware. Details of these methods, as well as preliminary results and observations will be given.

All Scottish Universities now have studio based video conferencing facilities. As part of the SUMSMAN project, a pilot scheme of video conference lectures which make use of the MANs has been given. Staff and student perceptions of the success of this pilot so far, will be examined.

Introduction

Educational Climate

The capability and usage of Communication and Information Technologies (C&IT) have exploded over the last twenty years. Computers have become so much part of our lives that it is difficult to imagine a time BPC (Before PCs!). The technology has advanced faster than our ability to think up ways of using it to its full potential. Not only is the hardware accelerating in power, but the infrastructure within which PCs are used, is becoming capable of handling more and more electronic traffic.

Dearing recognised that the exploitation of these Communications and Information Technologies holds out much promise for improving the quality, flexibility and effectiveness of higher education (Dearing, 1997). The Dearing Committee envisage that C&IT will overcome barriers to higher education, providing improved access and increased effectiveness, particularly in terms of lifelong learning. Classes in a particular place at a particular time will be replaced by access to resources that are time and place independent.

With the continuing pressure on costs and an increasing demand for places in institutions, it is important that consideration of quality within education is kept very much to the fore and that technology does not drive the strategy.

Over the last few years, there has been a paradigm shift in education, from teaching to learning. The role of the teacher is changing to become more a facilitator of learning rather than an expositor; students are encouraged to take much more responsibility and control of their own learning in an active way rather than in the traditional passive way.

A call for expressions of interest within the European Union in educational software and multimedia, resulted in a high response from enthusiasts convinced of the need for educational multimedia and a general need for a major innovation of the educational system (European

Commission 1996). It was recognised that the learning process must become more learner oriented, whereby the learner is actively acquiring knowledge and skills using not only the conventional tools such as books and teachers, but new technology based tools that enable learning at a distance and lifelong learning.

The numbers in higher and further education have increased dramatically over the last ten years; there is a far higher proportion of young people continuing with education after school and many more mature students either retraining or enhancing their skills. In its Green Paper on lifelong learning, the Government proposes to expand further and higher education in England to provide for an extra 500,000 young people and adults by 2002 (The Stationery Office, 1998). It also proposes to widen access to learning in further, higher and adult education and through the University for Industry, which will take its first students in late 1999. The University for Industry will use leading edge technology to make learning available at work, in learning centres, in the community and at home. The Government also intends to raise quality and standards across teaching and learning after the age of 16, by ensuring implementation of the Dearing Committee proposals and by inspection in further and adult education. The issues covered in the Green Paper are relevant in Scotland also.

Education is seen as being imperative for the development of our societies and economies across the world. There is a general recognition of the importance of the role of technology in helping to maintain and improve standards and quality in education, in the face of increasing numbers and pressures on costs. The Dearing Committee noted however that there was as yet, little widespread use of computer-based learning materials (Dearing, 1998). This was attributed in part to

- the limited availability of good materials;
- the time and effort required to redesign programmes to integrate computer-based materials;
- the reluctance of academics to use teaching materials created by others.

This paper describes the evaluation of a project which attempts to integrate two computer-based learning packages, a computer-based assessment system and video conferenced lectures into the first year teaching of several different universities. The topic of the software and the lectures is mathematics and statistics but many of the tools and lessons learnt can be generalised to other topics.

SUMSMAN

Higher education in the UK has one of the most technologically advanced networks in the world. All higher education institutions in the UK are linked into the network by high speed connections, as are about 90 further education institutions. Electronic traffic over this network has increased 25 fold over the last three years. In addition to these networks, there are even more advanced networks - Metropolitan Area Networks - which permit very high speed, sophisticated high quality network communications. As part of a Government initiative to encourage use of the MANs, Napier University is leading a project called SUMSMAN (Scottish Universities' Mathematics and Statistics across the MANs). This project seeks to find a core curriculum for first year undergraduate teaching in these subjects and to share learning and teaching resources in the form of multimedia software and video conference lectures by means of the MANs. It is also developing further the Mathpool system for storage and retrieval of electronic files relating to mathematics and statistics teaching in Scottish Universities.

In any such project, it is important to report on any problems encountered and lessons learnt, and to establish guidelines for the future. In order to do this, an evaluation strategy, linked to the aims of the project must be built in from the start.

Evaluation methods

There are four general types of evaluation which have been proposed: formative, summative, illuminative and integrative. The aim of formative evaluation is to help improve the design of the CAL. This is carried out on real students while the software is being developed and there are still resources to modify it. Summative evaluation is generally carried out after the software has been produced and to help users choose which piece of CAL to use and for what. Illuminative evaluation is an open ended method which aims to uncover unexpected important issues in a particular situation. It is a systematic focus on discovering the unexpected. The aim of integrative evaluation is to help users make the most of a given piece of CAL. Often the issue is not whether to use a particular piece of software, but how to make the best use of it. It is a type of formative evaluation, not of the CAL, but of the overall teaching and learning situation; problems identified in the use of the CAL, can be responded to by the teacher e.g. by producing a supplementary handout. In practice

there is often overlap of these different evaluation types (Draper 1996).

In order to carry out these evaluations, a variety of techniques can be used, using opinion, memory and observation, and involving experts, teachers who teach the material and actual learners. In general, an expert's opinion is less valuable than that of a teacher trying out the material with students; this in turn is less valuable than the opinion of actual learners (Draper 1995). In the initial stages of evaluation, on the spot observation is generally more valuable than questionnaires and interviews relying on memory, as unexpected problems and issues can be detected. Similarly, in any subsequent questionnaire, it is important to include open ended questions as well as fixed response questions in order to identify more unusual problems or problems not previously identified. The use of split screen video and thinking aloud protocol is a useful technique which can yield surprising insights into a user's perception of a system (Crerar and Davidson 1994).

As the aim of this evaluation was to assess the effectiveness of the different educational interventions, and to explore the barriers to the take-up of the technology, the approach taken was to involve all the participants in the learning experience i.e. the students themselves, the lecturers/tutors and the course co-ordinators. Different evaluation instruments require different amounts of effort on the part of the evaluator and the respondents. Response rates from student questionnaires can be very poor if the questionnaires are not completed during a class. This however requires precious time allocated to teaching. The usefulness of the information can also vary. Questionnaires can be limited in the information provided but are easy and cheap to administer to a large number. Structured open-ended discussion with a group of students can reveal much wider and deeper information, but is much more demanding on resources for larger numbers. In order to take account of these factors, a variety of instruments have been used to try and evaluate the project as fully as possible.

It was recognised that, in some universities, staff within the Maths and Statistics Departments would not necessarily carry out all the teaching of maths and statistics; some service teaching would be carried out by staff from other Departments. In order to ensure consistency, it was decided to restrict the coverage of the project to teaching by staff from within Maths and Statistics Departments in Scotland.

Early on in the project, an evaluation planning questionnaire was sent to contacts within each university, for distribution to other staff within their department. Members of the SUMSMAN team also made visits and presentations to all the universities to ensure that staff were fully appraised. The purpose of the questionnaire was two fold: to make staff aware of the resources available within SUMSMAN and to quantify the intention to use these resources. Six of the thirteen universities responded saying that they would consider using at least one of the 29 topics in Mathwise or Statwise; this covered 31 courses but were mainly from the new universities.

Core curriculum

The first step in trying to establish a core curriculum in first year undergraduate teaching in mathematics and statistics was to send a questionnaire to all first and second year module leaders in Maths and Statistics Departments within Scottish Universities asking them to indicate which of a detailed list of topics were included in their teaching.

Video conferenced lectures

Video conference suites are available at all the Scottish Universities. A lot of these are relatively new and no use had been made of them for delivering lectures in maths or statistics prior to the project. Over the first semester of 1997/98, a course in Calculus of Variation, delivered by a member of staff at Napier University, was shared by Napier and Stirling students, using video conferencing over a six week block. A video conference session was also held between Paisley and Napier to introduce and demonstrate one of the Mathwise modules. Feedback from students was obtained using questionnaires and a focus group.

Software

Maths and statistics CBL (Mathwise and Statwise) were made available to all Scottish Universities by FTP over the MANs. In addition maths assessment software (part of Mathwise) was also made available. Use of FTP over the MANs meant that universities could very easily obtain updates of the software.

Views on the software were sought from students via questionnaires and focus groups, two of which were video conferenced. Confidence logs were used to assess any change in the student's confidence as a result of using the software. These were completed

after each topic on the software. An expanded version of the confidence log was also used. This version included a short test question which the student attempted prior to using the software for that topic and a similar short test question after using the software. Students were reassured that it was the teaching that was being evaluated, not them.

Questionnaires were used to elicit views of staff. As well as finding out the reactions of staff who had used the software with students, it was felt that it was also important to investigate the reasons why other staff had not used the software with students and different questionnaires were used for staff who had used the software with students and those who had not.

Database of electronic resources

No formal evaluation has yet been done on the use of Mathpool - the database of electronic resources. Questionnaires for users and non-users of the system are planned.

Results

The following paragraphs describe the preliminary results from the evaluation of the project and are based primarily on the first semester of 1997/98. The final report on the project due in August, will include results which also cover the second semester.

- **Core curriculum**

The curriculum survey has been completed and the various Mathwise and Statwise modules have been mapped to corresponding areas in the curriculum allowing the potential for use of the Mathwise/Statwise modules to be assessed. The most common topics in the curriculum which are covered by Mathwise modules, are discrete maths, complex numbers, rules of differentiation and max/min. The most common topics covered by Statwise, are probability, normal distribution and regression.

- **Video conferenced lectures**

Staff involved in the video conferenced lectures have not yet been surveyed, but the students involved all completed questionnaires and a focus group was held. Examination results for those students who received a complete set of lectures on a topic were also studied.

Sixteen students attended a one-off video conference introducing one of the CBL and computer assessment packages. Eight students were at Paisley where the author of one of the CBL packages demonstrated the software, and eight were at Heriot-Watt where the assessment package was demonstrated, also by its author. The student comments were predominantly positive, and 87% thought that it was more interesting than an ordinary lecture; however, they also agreed that this was partly because it was a new experience. All but two students said that they would like to have more classes with video conferencing, held in addition to normal classes. Almost half felt that they had learned more than if the same material had been presented in a normal lecture, and felt that the most important advantage of video conferencing was that 'Material can be presented by experts'. The main disadvantage was the small size of the screens.

Twenty students were taught Calculus of Variations by means of a series of six video conferenced lectures. Seven of these were at Napier where the lecturer was and thirteen were at Stirling. The Stirling students followed the lectures with on-site tutorials which they found 'very valuable'. After six sessions, students' feelings were evenly split between positive and mildly negative, whether they were at the remote site or on the home site. Only 19% of the students now thought that video conferenced lectures were more interesting than a normal lecture, and only 24% agreed that they would like to have more video conferenced classes. This perhaps indicates that after six classes the novelty had worn off. All of those wanting more were from the remote site; the home-site students and the other remote students were undecided. The fact that the home-site students had had to travel to a different (and unpopular) campus to attend the lectures was probably significant here. None of these students felt that they had learnt more from the video conferenced lectures than an ordinary lecture - many said that they found it harder to concentrate, particularly those on the remote site. All said that they had sufficient opportunity to ask a question, but many said that they felt slightly more inhibited than usual and did not do so. No one who was on the remote site asked a question. The main advantage that these students saw to video conferencing was that classes can be run even when there are too few students wanting to take that subject at any one university.

Examination results for Calculus of Variations showed that the students had in no way suffered academically as a result of the video conferencing. At Stirling where students had a completely free choice of question (any 6 out of 8), the two Calculus of Variations questions were joint first and third in

popularity. On average marks (median) they came first and sixth. At Napier where students had to do two Calculus of Variation questions and two other questions, the two Calculus of Variation questions had the highest average marks.

Software Integration

The way that software is integrated into a course can have a marked effect on how well the software is received. It is not so much the success or failure of particular teaching material that should be studied but the whole teaching and learning situation in which the material is used (Draper et al, 1995). The aim should be to identify which factors are most important in a particular teaching situation and consider how teachers can make better use of software by adjusting how it is used. One teaching method in isolation is rarely the optimal way of encouraging learning. Rather a teacher would employ a number of methods or resources such as lectures, tutorials, handouts, homework exercises, etc. If it became apparent that the software did not handle a particular topic very well, a lecturer could adjust the teaching e.g. with an additional handout.

Different universities integrated the software in different ways. Napier, Paisley and Heriot-Watt used Mathwise during a supervised lab along with lectures and tutorials, Napier used Statwise in the same way. Abertay used Statwise instead of a conventional lecture as directed study but issued a handout including screen dumps and clear directions as to which pages to visit.

Student views

Questionnaires were received from 146 students from Napier, 55 students from Paisley and 27 students from Abertay. A video conferenced focus group to discuss the use of Mathwise also took place between Paisley and Napier with five students from each University. An attempt was made to conduct a video conferenced focus group between Napier and Abertay to discuss the use of Statwise, but there was a shortage of volunteers from Abertay. As a consequence, the video conference session went ahead but recorded a focus group for students within Napier and staff from Abertay sharing their experience of using the software with their students.

The main lessons learned so far about how students, from experience, think CBL can be best used in a course are as follows. Where opinions appeared to depend on factors such as how they actually used the material, how often they used it, their course of study, gender age etc. these factors are mentioned; in general, however, the responses were remarkably consistent. The responses received so far are from 246 students at three universities on a wide range of courses: psychology, engineering, mathematics, science, business and accounting. Some had used the CBL only once, but others had used it more than eleven times; the average was five times. Almost all (98%) had used it in supervised labs with about a third also using it in their own time. Only 28% were learning the material for the first time, most were practising material they had just been taught. Most (84%) had been tested on the material of the CBL by the time they completed the questionnaires, 61% of these using the computer for their test. 43% had had paper-based materials specially written to go with the CBL package, but most (76%) had not had to do homework associated with the CBL.

69% found that the methods, formulae etc. in the CBL matched those used in their lectures 'Fairly well' with a further 24% finding it matched 'Very well'; 60% thought that the closeness of the match was 'Fairly important' and 22% 'Very important'. 56% found the CBL 'Quite useful' and 17% 'Very useful', the remainder finding it of only 'Marginal use'. Those who thought that the CBL did not match their lectures 'very' closely were more than twice as likely to find it of only marginal use, and those who thought it matched 'very' closely were more than three times as likely to find it 'very' useful. Students who found the pace of their lectures 'Too slow for me' were three times as likely to find the CBL of marginal use; those who found the lectures 'About right' or 'Too fast for me' differed little in their responses.

Students overwhelmingly (81%) thought that CBL was best used in supervised labs, and that its best uses were for practising material they had just been taught (79%), trying to understand material they were unsure of (56%), and revising before an assessment (53%). Learning material for the first time was thought to be a good use by only 20%. 60% said that an imminent test made them use the CBL more, whether that test was computer or paper-based.

The majority (64%) thought that CBL was best used 'Sometimes alone, sometimes with others'; and 41% would have been willing to pay up to £20 to buy the package for home use.

Students were asked to rank various activities for how effective they had been in helping them learn the subject: on average, 'lectures' and 'tutorials' were

ranked roughly equal first, followed by 'supervised CBL', then 'other self study' and finally 'CBL in your own time'. The latter may suffer from the fact that few of them tried this activity and so it had not had a chance to 'help them learn'. In fact, when asked if, ideally, they would like more time per week on each activity, 30% wanted more time on CBL in their own time, whereas only 14% wanted more time spent on lectures and only 24% more time on tutorials; 19% wanted more time spent on supervised labs. Those who had used the statistics package ranked CBL (both supervised and own time) significantly higher than those who had used the Mathwise modules. Rankings differed slightly between universities: Paisley ranked 'other self-study' above either form of CBL, and Abertay ranked supervised CBL above both lectures and tutorials.

Those who had had accompanying paper materials had overwhelmingly (74%) found them 'Very useful' and 60% of those that didn't have them picked these out as something that would have greatly enhanced their learning from the CBL. Other things picked out in this way were: a bulletin board of responses to frequently asked questions, faster and more computer facilities, and marked homework sheets with feedback. Interestingly, of those who had been given homework on the CBL material, those who admitted to not doing it found the CBL significantly less useful.

Of the 110 students who had been formally assessed using the computer-based assessment package, 48% felt that they would have done very similarly on a conventional paper test. 23% felt they would have done worse on a paper test (mainly because they thought it was easier to guess on a computer test), and 29% felt that they would have done better on a paper test (the main reasons given being the difficulty and the time it took to enter answers correctly, that the computer cannot give marks for correct methods or partially correct answers, and that the package did not allow them to go back and change an answer after doing another question).

The majority (63%) reported no technical problems, but some (18%) complained that the packages ran very slowly on their computer networks, and a few (6%) complained about having to change campus to access the CBL. Only 2% reported 'crashing' or similar problems.

Finally, the students were asked to state what they saw as the drawbacks and the benefits of CBL. Tying for most common entry under Drawbacks was 'none', together with 'problems entering mathematical expressions in the test'. Other drawbacks mentioned were that it was 'too easy to just flick through' CBL, that it was 'hard luck if you don't like computers', and that it was 'hard to remember what you had done if there were no paper-based material to go along with it'. In the focus groups a student pointed out that "if you don't grasp something a lecturer can explain it a different way or in a different context to help you understand, whereas a computer can't". Students were also worried about some of the randomly picked computer-based assessment questions being easier than others, and that only answers to questions could be marked, not the development of that answer.

The most commonly mentioned Benefits were, in order: 'good for practising exam questions', 'good for revision', 'can go at one's own pace', 'helps understanding', 'can use at any time', 'can go over something again and again', 'good backup for lectures', 'instant feedback on exercises', and 'provides variety'. In the focus groups a student remarked, tellingly, "I don't think there were any bad points. I think that if you had enough time to sit down and work your way through it methodically, you could learn the subjects well, but it is difficult to get the time (on the computers)." "In an ideal world, this would be like having a tutor in your house." Another remarked, "Going at your own pace freed up the tutor to help the people who really needed help." Yet another amplified a remark made on a few questionnaires that they liked being able to choose for themselves what they looked at, many preferring to go almost directly to the examples and exercises and skip the theory at first.

Focus group students were additionally asked to compare CBL to learning from a textbook: students felt that "CBL is more interesting than a dusty book" and that "animations keep you interested". They also added that, "in CBL you have to try the exercises before you get the solution".

Results from the basic version of the confidence logs did not supply a great deal of information; about half of the students felt the same confidence about a particular topic, the other half felt more confident.

Results from the version of the confidence logs where the students tackled a short test question both before and after using the software were inconclusive. Results varied by topic. This was thought to be more a product of the questions set rather than as a consequence of the software. For

some topics it became apparent that the questions were too long; students did not allow enough time at the end of the class to complete the question and rushed it.

Results from basic confidence logs

	Mathwise (206 student-topics)	**Statwise** (369 student-topics)
less confident now	3%	0%
about the same confidence	61%	47%
more confident now	31%	41%
much more confident now	5%	12%

Staff views

The staff who had used one of the CBL learning packages supplied by the project covered a much wider age range than those who had not used the CBL. The latter had all taught in HE for over 10 years and were all male, whereas the former were evenly spread from under two years to over ten and were evenly split between the sexes.

Of those who used the CBL, only 40% had actually been involved in the decision to use the CBL with their students, and these people were all involved in the SUMSMAN project or in other CBL projects. Only this 40% had ever used CBL before. 60% of those who had not used CBL before said that their opinions of CBL had improved as a result of using it, as did 25% of those who had used CBL before; the opinions of the rest remained the same. Everyone of them said that they would continue to use the CBL next year, some with additional classes, and all would encourage others to use it.

73% thought that the CBL matched their teaching 'Very closely' and the average time that it was appropriate for was 6.4 weeks. Those who had used CBL previously seemed to get a more positive response from their students than the first timers. Generally, the staff feelings about the best way to use CBL, the benefits, the drawbacks etc. matched those of the students very closely. The main changes in how they would use it next time were to 'introduce the material first' or to 'introduce the students to the package more positively'. The main perceived benefits to staff were overwhelmingly that it saves time preparing exercises, examples, tests and homework, but also that it provides an alternative learning resource and/or experience.

Of the five staff respondents who had not used the CBL, all had a low or fairly low opinion of CBL for maths or statistics. Four of the five had had a detailed look at one of the CBL modules, but only one knew whether there was a module that matched what they were teaching. 60% were unaware that paper materials existed to go with most of the CBL modules, and 40% were unaware that computer-based assessment was available. 80% were unaware that the statistics CBL was available on CD for students to buy.

Reasons given for deciding not to use the CBL were: lack of time to plan for it, doubt over its suitability of level or approach, shortage of labs or hardware, and that it did not match their teaching structure. There was a fear that it might require additional staff time and training. Traditional university teaching methods were mainly used instead, though one team were using prepared booklets and interactive lectures with their students.

Success of the evaluation methods

Student survey

The main benefit so far has been the extensive feedback we are gathering from students on various different courses, at a range of universities, all using the software in different ways. Eventually this will allow us to establish guidelines for the best ways to use CBL in mathematics/statistics. The questionnaires have been very successful, yielding a lot of information from complete sets of student users. Despite being quite long (four pages) there is little evidence of lack of care in their completion - almost all students were still willing to write sensible and sometimes extensive comments in the open questions at the end.

Focus groups have, as expected, given fuller information though from only a few people. Being a group ensured more detail in the responses in that a comment from one individual would be taken up and developed by others, and in that the interviewer could ask for clarifications or explanations where necessary. To aid this clarification, it was helpful to have the package to hand on a computer. Taping the interviews is vital if points are not to be missed when the discussion gets going. Using video conferencing between groups using the same software but from different universities added to the interest for the students and allowed discussion of new points that had not occurred to one or other of the groups. It was probably, however, somewhat intimidating at first and the discussion took a while

to get going. A demonstration of the package was a useful reminder at the start, after an ice-breaking introduction of the participants to each other. In retrospect, clear name badges on the participants would have been a good idea. Five students at each site proved a workable number: fewer would have been difficult, but up to twice that would have been okay.

For the Napier/Paisley video conference focus group, only about half of those who had 'promised' to turn up actually did so at each site, even given the offered 'reward' of a pint in the union afterwards! At the Napier/Abertay video conference focus group, no students could be persuaded to participate at Abertay. The session was conducted as a student focus group at the Napier end, with staff from Abertay sharing their own and their students' experiences with Napier.

Staff survey

Getting information from staff proved much harder than getting it from students. At the start of the project (summer 1997), every Scottish Maths or Stats department was asked to identify people who were willing to consider using one of the CBL packages, and also those who would be willing to help in the evaluation. Towards the end of the academic year 1997/8, questionnaires were sent to all these staff, and, via the SUMSMAN contact at each university, additionally to two or three staff in each department who had decided not to use the CBL.

Those staff who had used one of the CBL packages with their students were generally happy to fill in questionnaires (often preferring to fill in an e-mail version rather than a paper one); eleven have been received so far, plus two additional staff involved in a group interview. However, staff who had chosen not to use a package were very reluctant to fill in a questionnaire; only five have been received at present. Speaking directly to these people elicited reasons for this such as "I am involved in enough evaluations already" or "The questionnaire made me feel guilty for not using the CBL". Other staff are choosing not to respond yet because they hope to use one of the packages next year and would prefer to respond after that.

Despite the various software resources being made available to all Scottish Universities, there has been a low take up so far, especially from the older universities. This partly explains the low response from staff.

Further work

It is difficult to assess the success of the project at this stage since the evaluation is still on-going. However many lessons have been learnt about the relative effectiveness of the evaluation instruments and these will be refined for future use. The evaluation itself has been formative for the project and many of the experiences have led to improvements in the way the technology is integrated. These improvements will themselves be evaluated. A number of staff indicated their intention to use the software in the future, and longer term surveys of usage may indicate increases in the integration of these technologies. Considerable work has still to be done and questionnaires are coming in every day. Usage of the electronic database has still to be assessed. More split screen videos and focus groups are planned, together with interviews of key staff at the end of the year. It will also be interesting to discover whether the initiative continues after the disbandment of the original project team.

Encouraging the integration of new technologies is an iterative process. It can not and should not be expected that all staff will adopt them straight away. There is inevitably an investment of time and effort in investigating the potential of any new technologies and adapting courses to incorporate them. Evaluation studies such as this will hopefully assist, in disseminating lessons learnt about the best ways of integrating them.

Eventually, guidelines, based on what the evaluation has discovered, will be produced on the best ways of using each of the resources and enhancing the learning experience. Hopefully this will overcome some of the barriers identified by Dearing, and lead to wider use of computer-based learning materials. However IT is used in higher education, it must be understood not just as an add-on, but as value-added (D'Andrea, 1997).

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Leading New Teachers to Learning Technology....

Jan Drysdale & Linda Creanor, Glasgow Caledonian University

Abstract

Providing an introductory course in learning and teaching has long been a core activity in staff and educational development at Glasgow Caledonian University. However, a fundamental re-appraisal of course delivery was required. The new approach, piloted in semester A 1997/98, incorporated several key features:

- Web-based study guides and reference materials;
- Structured readings to support work-based learning activities;
- Attendance at three tutorials during the semester;
- A Hypernews discussion group;
- Reflection and self-assessment.

The web site was designed to provide a flexible, easy to use and attractive delivery structure with easy navigation between sections, with links to the course outline, direct e-mail contact with course tutors and online registration. To introduce the concept of computer mediated communication (CMC) to new staff, the hypernews discussion group has been set up as a forum for discussing the issues in teaching and learning which arise during the course.

Because this was a pilot, evaluation of both content and process was important. Criteria used were attendance and completion rates, quality of assessments submitted and qualitative feedback from discussion with the course participants. Responses were mixed. Few course participants completed all of the assessed elements but the self-assessments and the feedback from those who did were encouraging. Staff involved in delivering the course learned a number of valuable lessons which have been incorporated into course revisions for Semester B.

Introduction

At Glasgow Caledonian University, responsibility for providing staff development opportunities in learning and teaching lies with the Department of Learning and Educational Development. There are two main approaches to staff development: the Postgraduate Certificate in Tertiary Level Teaching Methods (TLTM) which uses a mentor-supported work-based learning model where the course participants work at their own pace to achieve personal and professional development in learning and teaching and an Introductory Course which is viewed more as a 'survival skills' training course and was, until 1997 delivered over a three day period.

Course redesign - the key questions

Why?

Evaluation of the Introductory Course over a two year period had shown that the biggest problems were:

- its target audience was frequently too busy to attend;
- it was not credit rated either for TLTM or Continuing Professional Development (CPD);
- it didn't fit into the ethos of personal and professional development we were encouraging in TLTM.

Clearly a fundamental re-appraisal was needed. Additional stimuli for change included:

- the appointment of Prof. Terry Mayes within the department to spearhead developments in learning technology within the university;
- the award of a capital sum for the purchase of a departmental web server;
- the appointment of a Learning Technology Support Officer.

Thus, the remit in revising the induction course was to integrate it into the CPD framework, make it more accessible to its target audience and more innovative in its delivery. One explicit function of the redesigned course was to ensure that new staff gained hands-on experience of using learning

technology and the opportunity to reflect on whether and how it could be incorporated into their own teaching.

What?

Believing in the systems approach to curriculum design as we do, the first thing was to clarify the training need and to interpret that into a set of objectives and a delivery structure for the course. Because the course participants come from such diverse backgrounds, the new course had to incorporate a degree of flexibility so that participants did not need to spend a lot of time on topics of only marginal relevance to them. Nevertheless most, if not all, of them would be preparing materials to use in their teaching or to give out to students, delivering lectures, and working with small groups in tutorials, seminars or practicals. Some would also be involved in assessing student learning. The delivery model would be required to integrate with the TLTM modules so a work-based learning approach was adopted and the following series of objectives, based on those used in the previous course, drawn up:

At the end of this course you should be able to:

1 describe, in broad terms, the operation of the university's academic structures and procedures;
2 prepare high quality materials for learning and teaching which are appropriate to your teaching;
3 prepare and deliver effective lectures;
4 select and use appropriate group methods to enhance students' learning;
5 appraise the validity, reliability and practicability of instruments of assessment.

Two other objectives were added to indicate that this was only the start of CPD in learning and teaching and to ensure that the course participants were at least aware of current possibilities in learning technology:

6 produce an action plan for your personal and professional development;
7 as a student, use learning technology with confidence.

How?

Immediately we were looking at something which would take place over a much longer time scale than the previous three day Introductory Course so it seemed logical to extend the course over a semester and let course participants work their way through the various parts of the course as the demands of their teaching commitment dictated, much the way people work through TLTM but TLTM course participants have a mentor. How could we support these individuals through the semester?

One of the best features of the previous Introductory Course was the opportunity it provided for interactions not only with staff from LED but also with other new teachers from a range of disciplines and to share their concerns and classroom experiences. In an attempt to retain these benefits we opted for a multiple media delivery model emphasising learning and professional development through four types of activity:

- individualised learning based on the course web pages and associated print-based materials;
- practical activities based on the individual course participant's teaching;
- attendance at periodic tutorials with LED staff;
- computer-mediated conferencing.

But how would we know if they really had done it? We took the radical step of introducing an element of assessment into the course. This fulfils several functions. It tells us that the course participants have worked through the required elements of the course. It also enables us to award a certificate to those who successfully complete the course and this counts for CPD as well as providing credit towards some of the TLTM modules.

The next stage was to develop the materials for the web site. These fell into three types namely information pages outlining the requirements of the course and its delivery model, reference pages on professional development issues, structures and procedures and the study guides themselves.

Online delivery

The task of converting a more traditional paper-based course to an online delivery mode requires careful planning. As a starting point, it is often advisable to take a step back and re-think what is to be achieved through this alternative delivery medium. What 'added value' can the Web offer to deliverers of course material and their students?

In this case, the main aims were to increase the flexibility of delivery and to decrease the amount of time hard-pressed academic staff had to devote to attending face-to-face tutorials. The secondary aims were to harness the capability of the Internet to enhance communication and to raise awareness

among the course participants of its potential for teaching and learning.

In order to achieve these aims, and to provide a pedagogical model which was both simple and effective, we developed a frame-based layout which allows a consistent interface throughout and helps restrict navigation to within the course materials. These consist of the four Study Guides:

- Presentation Techniques and Instructional Materials;
- Lecture Techniques;
- Group Methods;
- Student Assessment.

Each Study Guide leads the course participants through the recommended readings, followed by a variety of work-based activities which they are expected to carry out as part of the assessment for the course, and finally they also provide access to an online discussion. Within each section there are also a number of links to other relevant web sites such as information on the Scottish Higher Education Funding Council, the ubiquitous Dearing Report and several interesting articles on teaching and learning from the Times Higher Online. In addition to these are two reference sections containing information on Glasgow Caledonian University's Structures and Procedures, and some advice and current thinking on Professional Development.

To encourage awareness of the Scottish Metropolitan Area Networks (MANs) which are impinging on all areas of learning and teaching in HE, we decided to link directly to Clyde Virtual University (CVU), a collaborative project on the ClydeNET MAN in which Glasgow Caledonian University is a participant. We made use of CVU's facility for hosting Hypernews discussions for the local universities, and hoped through this medium to encourage informal discussion on a variety of the course issues. In order to encourage participation it was decided to make contributing to the discussion a small part of the overall assessment for the course, and direct links were made to it from each of the four Study Guides. For these pilot sessions the discussion has been restricted to course participants, but there is the potential to share both this and the course materials with other local universities, and invite well-known 'experts' in the field to join in a debate on some of the issues.

Finally, thought had to be given as to how the online course materials would be accessed by the users. In order to give the course a high profile two main links were created from the home page of Glasgow Caledonian's Centre for Learning and Teaching Innovation. The first leads to a widely available information section which gives details of the target audience and an outline of the course content. It also includes an online application form for prospective participants which is automatically sent to the course tutor on completion. The second link gives access to the actual course materials which for copyright reasons are password-protected. Staff are issued with an individual username and password when they have enrolled for the course. This does have implications for administration, but as the numbers on the course are restricted to around twenty, it is not an excessive burden. The advantage is that tutors have full control over who can access the course materials.

Evaluation and Feedback Semester A 1997/98

The revised Introductory Course was piloted during Semester A of the 1997/98 academic session. The course is obviously still in its formative stages so evaluation of both content and process was considered highly important for future development of the model of learning and teaching adopted. Criteria used were attendance at tutorials, completion rates, quality of assessments submitted and qualitative feedback from discussion with course participants.

Responses were mixed. Still, some observations and inferences can be made. The course began in September 1997 with 25 people registered as participants. They included lecturers, researchers and research students from all parts of the university, although one department had a fairly large 'block booking'.

Attendance at the three half day tutorials has been disappointing. It had been hoped that, by reducing the mandatory attendance and by spreading it over a longer time period, more participants would attend. In fact, of the 25 course participants registered, 17 attended the first tutorial. This number had dwindled to 6 by the third tutorial. Some of the absentees expressed valid reasons for non-attendance and concern at having 'missed out'. Others could not be contacted at all. It would seem therefore that we still have a motivational problem.

At the second tutorial course participants were asked to outline their progress to date through the course materials and activities. The responses were very disappointing but when it was stated that the model clearly was not working, this view was firmly

rebutted. Course participants argued that the due date for assessments was nearly two months off and therefore the activity had not been accorded the priority treatment that an assessment date would confer.

Some course participants have reported that they have problems accessing the materials on the web site. This is a particularly common complaint among the research students on the course who do not have PCs in their offices, although they are available in open access labs and libraries. Similarly this group is the one most likely to comment that the assessments are not appropriate to their situation because of the restricted range of their teaching. No-one has approached the staff associated with delivering the course to negotiate a way round this difficulty.

Six course participants, mainly the more mature members of the group, completed the assessments by the due date. The work submitted is generally of very high quality. In fact, it has been necessary in the feedback on these self-assessments to remind these individuals that a balanced self-assessment includes the good points as well as the not so good and the plans for improvement.

Qualitative feedback indicated that, in general, participants on the course did appreciate the flexibility which the web site provided. There were some inevitable problems with the technology which will have to be take into consideration for future courses. These included difficulties with access to computers, an unexpected 'firewall' between one of the smaller campuses and Strathclyde University in whose domain the Clyde Virtual University server resides, and the well-documented issue of the disappointing quantity of contributions to the HyperNews discussion group.

When asked, the reasons given for minimal or even non-participation in the online discussion were those of lack of time and lack of access. Heads of Departments may have encouraged new staff to attend the Introductory Course for Learning and Teaching, but often they did not support them by allowing them any extra time to complete course assignments or to contribute to the online discussion. Difficulty in gaining access to a suitable computer was a particular problem for part-time or research staff who did not have their own desktop machine. There is no immediate solution to either of these issues, but if departments wish their staff to participate in courses such as these, they will have to be made aware of the support they should offer.

The online course was successful in demonstrating to new staff a simple model of using learning technology, and giving them first hand experience of its use. It succeeded also in raising their awareness of current practices in this area, which they were encouraged to consider in relation to their own teaching. From this point of view it has certainly been a worthwhile exercise, and one from which both participants and course deliverers have benefited.

Changes for Semester B

As a result of our experiences in Semester A changes were made in course administration, the structure of the tutorials, the web site and the evaluation methodology.

The administrative changes were designed to target the course more effectively to staff who are at least relatively new to teaching within the university and who have a varied teaching commitment. There is general agreement that a different type of staff development activity should be organised for lab demonstrators who do not benefit from this Introductory Course. The memo to Heads of Department and the course participant registration form were rewritten to reflect the emphasis of the course and the necessity of course participants being given time and access to the IT facilities required to undertake the course.

The series of tutorials was restructured around an action planning and review cycle with course participants being required to submit by e-mail their action plans for development in learning and teaching during the semester.

For the second run of the course in Semester B a few additions and alterations were made to the web site. The main one has been the integration of online personal portfolios into which each participant can 'post' their outline development plans, reflections on their activities and final course assessments. This is done via online forms, the content of which is written to password-protected personal web pages accessible only to the individual student and their tutor. These portfolios build up to provide a useful record of an individual's professional development.

Another addition is an online evaluation form which participants are asked to complete when they have finished the course. The content of the form is e-mailed directly to the course tutors. Questions cover all aspects of the course from the organisation of the half-day tutorials and relevance of the course materials to the usefulness of the web site itself.

This should provide some useful feedback which will allow refinements to be made to future courses.

Initial Feedback from semester B and issues for 1998/99

Despite the tightening up of administrative procedures out of ten course participants registered for semester B, two subsequently withdrew, one because he did not have a teaching commitment at the time and the other because he had 15 years teaching experience in other universities. Two other members of teaching staff with some limited teaching experience chose, after some dialogue with the course tutor, not to register. Obviously there is room for more improvement in course administration.

The opportunity to discuss their experiences informally was well received and set the tone for frank and open discussions in all of the tutorials. Participants initially responded well to the action planning and review cycle. All but one of the nine active course participants did submit an action plan. Inevitably target dates in the action plans were not met but participants were encouraged to continue attending tutorials and working at their own pace throughout the semester. Attendance at tutorials was again a bit disappointing, reducing from seven of the active participants to four. Interestingly, though, apologies and reasons were given for absence in nearly all cases.

Qualitative feedback at tutorials has been very encouraging with all course participants indicating that they have found the experience to date positive and supportive. Use of the personal portfolios has been mixed. Some participants have submitted detailed entries explaining what they were seeking to achieve, why they decided on the approaches they did and how successful they found these approaches in practice. Others have adopted a much more superficial approach providing only outline answers. Two course participants have not used the personal portfolios at all. Clearly there is scope for further discussion and development here.

The Dearing and Garrick Reports place considerable emphasis on the importance of communications and information technology. Indeed the committee believes that,

> "for the majority of students, over the next ten years the delivery of some course materials and much of the organisation and communication of course arrangements will be conducted by computer".

It was hoped that by allowing staff first hand experience of online learning, they would be encouraged to think about using technology in their own teaching. They would also become aware of the issues involved and the implications for their own students. Some of these issues have certainly come to the fore during these pilot runs of the Introductory Course and have been highlighted in feedback from participants. These include access to computers, inadequate technical support, time management in a more flexible environment, and not least the effort required to participate in an online discussion.

The results of the online evaluation and assessments are awaited with interest!

Conclusions and ideas for further development

Our aim is to encourage course participants to become reflective practitioners. To do this we have encouraged course participants to evaluate their own experiences and share those experiences with the others on the course. The security blanket of the 'right' answers is not available, but access to a sympathetic audience, whether tutor or fellow course participant, either face to face or through electronic communication, is. The motivation levels among course participants appeared high in semester B. Still, there is always room for improvement. Some issues which need further work for 1998/99 are:

- preparing participants for the course by clarifying our expectations of them and making sure they are fully comfortable with the various components of the web site from the start of the course;
- making the web-based course materials more interactive, including more hot links to other relevant sites and maybe more online exercises for course participants to try eg using an assessment engine;
- encouraging more use of CMC.

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Evaluation of Computer-Assisted Learning Program Question Styles and Integration into a General Pathology Course.

W Alexander Reid & Mark J Arends, University of Edinburgh

Abstract

Background: Computer assisted learning programs (CAL) were integrated into an introductory course on general pathology for medical students in the University of Edinburgh Medical School. The study was undertaken to determine how the students reacted to the different question styles available in a package called CALScribe and how well the CAL was integrated into the course.

Method: Towards the end of the course, students were asked to complete written questionnaires.

Results: Students appreciated the different question styles to various degrees, preferring MCQs of either conventional or latent type over free response, modified essay or image-based questions. Students also felt that the CAL was well integrated with other parts of their teaching and helped them to understand more about the subject material.

Conclusion: Students found the CAL an effective learning tool which were well integrated with other course components and they most appreciated MCQ style questions.

Introduction

CALScribe is a set of templates developed at the Computers in Teaching Initiative (CTI) Centre for Medicine, Bristol (Whittlestone & Williams, 1995). These templates operate within the software package Toolbook 4.0 and allow entry of text and various styles of question. CAL written with these templates have been used since 1997 as part of the introductory teaching programme in general pathology for second year undergraduate medical students in the Pathology Department, University of Edinburgh. The CAL programs were integrated into the course so that the material interlocked with that covered by the other teaching methods, including lectures, tutorials for groups of 17-18 students, autopsy demonstrations, problem solving exercises and clinical cases with microscopy. The students were timetabled to work on the CAL in tutorial groups for one hour per week, although the computer cluster was freely available at other times.

In the year under study (1998), 215 students participated and the course lasted eight weeks. As part of a larger study of the CAL packages used in the course, it was decided to investigate the use of different question styles available through CALScribe and how the students viewed the degree to which the CAL was integrated into the course. The study entailed using questionnaires at the end of the course.

Method

The CALScribe templates were downloaded from the CTI Centre, Bristol and were used to develop computer-assisted learning programs in pathology in the University of Edinburgh (Boyle, 1997). Thirty eight programs were relevant to the introductory course in the present study. The CAL packages run on the university computing network and are accessed in a cluster of 100 PCs in the Greenfield Suite, Medical School, University of Edinburgh. Each CAL program consists of a series of text and image screens interspersed with various question styles. In most cases the student is allowed two tries at a question and receives an appropriate response from the computer.

Question styles available:

- Free response questions, where the student types in a short answer. A correct first attempt gains two marks and a correct second attempt gains one mark.
- Multiple choice questions (MCQs) of conventional style of stem with five items, each true/false, with negative marking for incorrect responses. The scoring was followed by an explanation.
- “Latent MCQs”: stem and five items, but differing from the conventional MCQs in that selection of each item is immediately followed by a score and immediate revelation of a hidden (“latent”) explanation. Marks (positive only) are given only for a predefined number of attempts.
- Image-based “point to” questions, where the student is asked to select part of an image with the cursor. The computer responds by showing

the correct area and awarding a mark if the area has been correctly identified.

- Modified essay questions: the student enters a more detailed answer, often in response to a conceptually more challenging question. A model answer is then revealed and the student is invited to award him/herself a mark out of 4.

Questionnaires

Towards the end of the course students were asked to complete questionnaires on their opinions of the different question styles and their perceptions of how well the CAL was integrated into the course.

Results

The students were asked how they rated each of the following question styles used in the CAL in terms of helping them learn (124 respondents)(SD =strongly disagree, D=disagree, N=neutral, A=agree, SA=strongly agree)

Table 1

	SD	D	N	A	SA
Free response, where you type in the answer	5	14	28	50	26
MCQs, 5 items, true, false with explanation box	1	0	11	43	68
Latent MCQs, with answer appearing after choosing each item	1	5	24	42	49
Modified essay questions, where you award yourself a mark	14	27	42	31	7
Questions where you point to something on a picture	1	7	31	46	35

These results are also shown in Table.1.

Students were invited to write comments on the CAL and reported that the most useful aspects of the CAL were the questions and answers, summaries at the end, pictures, learning at one's own pace and practice in doing questions, especially MCQs: "Self-assessment enabled me to quantify my knowledge and note which areas required improvement". Some students commended the interaction generally: "One cannot go through the programs passively without learning anything". Other positive comments included "integration with problems in tutorial sessions", "going through topics in simple, easy, logical stages helps understanding" and "interesting to use, seemed relevant and concise". Among the least useful aspects of the CAL featured excessive detail, lack of time and uncertainty about the depth of knowledge necessary, while a few found the humour annoying.

The students were also asked how the CAL was integrated into the course: did you feel that the CAL packages:

Table 2

	SD	D	N	A	SA
were linked into other parts of the pathology course	1	1	17	70	33
helped you understand more about the subject	1	1	16	65	41
helped you prepare for other parts of the course	2	12	48	44	18
explained some concepts that you had found difficulty with	2	4	24	66	28
made you feel like reading more about the subject	9	27	54	26	8

These results are also shown in Table. 2.

In a further questionnaire on the whole course, 131 students replied to the following question: If the pathology course were to be changed would you prefer to see CAL time (0=not at all, 5=certainly):

	0	1	2	3	4	5
decreased	25%	16%	18%	13%	20%	6%
increased	19%	16%	20%	18%	9%	13%

Discussion

The respondents tended to favour both types of multiple choice question (modal Likert score 5) over free response questions and "point to" questions (modal Likert score 4), but were less well disposed towards modified essay questions (modal Likert score 3, with a balanced spread of opinions). This could reflect the relative importance of MCQs in the end of course examinations, which comprise (marks in brackets): written paper (60%), MCQ paper (20%), practical examination (20%). During informal discussions with the course organiser (MJA), students often voiced concern about the MCQ component of the examination and many requested MCQ practice sessions. The effect of CAL or any other single learning technique on students' final performance in examinations is, of course, extremely difficult to measure, as this depends greatly not only on the nature of the examinations themselves, but also on other factors, such as self-esteem and achievement motivation (Abouserie, 1995).

The students felt that the packages were well integrated into other parts of the course, helped them understand more about the subject, helped them prepare for other parts of the course and explained some difficult concepts, but they appeared neutral about whether they were induced

to read more about the subject. This could reflect the relatively intensive nature of this part of the medical course. The students also indicated that they would welcome an increase in CAL teaching time with various degrees of agreement (13% certainly, 19% not at all), but fewer favoured a decrease in CAL time (6% certainly, 25% not at all), with a similarly broad spread of opinion.

It is important for any CAL program to be incorporated fully into the course (Crook, 1994), not just made available as an optional extra. This promotes discussion of the material in relation to the other aspects of their work. In our study, the students felt that the packages were well linked into other parts of the course.

Conclusions

Students had a highly favourable view of CAL, appreciate that CAL are effective learning tools which were well linked to other course components. Although all question styles were appreciated in making the CAL interactive, a preference was expressed for MCQs of either conventional or latent type.

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Evaluation of Learning Technology Implementation

Professor Barry Jackson, Middlesex University

Abstract

Learning technologies present the opportunity to augment or replace the role which was traditionally played by the teacher. In a learning-led educational context the effectiveness of teaching, whether by the teacher, or through interaction with media, can be readily evaluated by the degree to which it contributes to learning. The use of level descriptors, such as Biggs' SOLO taxonomy, provides a powerful tool to assess the outcomes of learning, and by implication the effectiveness of the learning activity. Contextual factors which correlated with the SOLO levels, and encourage deep approaches to learning, can be used to improve effectiveness. This paper outlines the SOLO taxonomy, indicates implications for implementation, and discusses the correlating factors which enhance students' approach to learning.

Purposes and scope of evaluation

> 'Evaluation is any activity that throughout the planning and delivery of innovative programmes enables those involved to learn and make judgements about the starting assumptions, implementation processes and outcomes of the innovation concerned'
> Stern [1988]

Under this definition the principal purpose of evaluating learning technologies is to provide the designer or user with enough evidence on which to make confident judgements regarding the effectiveness of the innovation. From these judgements actions can be based which will result in the redesign or adaptation of the implementation to improve its performance. Judgements of the 'effectiveness of the innovation' are in effect judgements of the extent to which the innovation meets its identified aims - its fitness for purpose. It is important therefore that these intentions are thought through and clarified at the design stage of the project - good evaluation practice is designed-in, not appended, to projects.

There are three stages in innovative projects about which judgements may be made: intentions, implementation and outcomes. The match between the outcomes and intentions provides a measure of the success of the innovation. If outcomes do not match the intentions, then it is readily observed that something needs to be done: perhaps implementation is inappropriate, or perhaps the starting assumptions should be revisited and revised. Even when outcomes closely match the intentions, and the project is counted successful there may be assumptions, behind the stated aims of the innovation, often implicit and unstated. An innovation may be judged as 'fit for purpose' while the fitness of the purpose itself is questionable. It is important therefore to be as explicit as possible about the starting assumptions, in order that the evaluation of design and implementation can be most useful.

To take more concrete examples: a learning package might be evaluated against a number of intended outcomes.
These might include:

- ease of use - can the target users navigate and interact with the product in the expected way?
- efficiency - does the product provide efficient coverage of the appropriate curricular unit? Can more multiple learners access the content than by other means?
- preferences - do learners enjoy it? will they choose to use it if it is offered? to what extent does it cater for variety of user?
- attractiveness - is it sufficiently attractive to persuade purchasers/tutors to choose it over alternatives
- cost effectiveness - is it cost effective in comparison with alternative means of achieving the same intended outcomes?

However, at another level there are assumptions about the nature of learning and learners, which will shape and define the answers to all these evaluative questions. It is to these assumptions that I wish to draw attention below - assumptions about learning at tertiary level which I believe are shared by most teachers, and which provide a necessary aspect of evaluation of any learning technology, alongside any of the aspects outlined above.

Evaluation of learning

The evaluative question I propose is simply stated thus: does the product provide opportunities for learning at an appropriate level? To answer this apparently simple question it is necessary to explore what we mean by 'learning' and 'appropriate level', since these are the assumptions which will shape the design of teaching materials, and their evaluation.

There are broadly two traditions of theories applying to higher education. The first is the objectivist tradition, which locates knowledge outside the knower. In this tradition knowledge exists independently of the knower, and understanding is coming to know that which already exists. In this tradition, knowledge is seen as independent of particular contexts: teaching is a matter of transmitting this knowledge and learning is a matter of receiving, storing and applying it.

The second tradition rejects the separation of knower and knowledge. In this, the constructivist tradition, knowledge is seen to be constructed by the knower in acts of understanding. Meaning is created by the learner, not simply received. Learning is context-sensitive: the learner brings to any learning situation an accumulation of assumptions, motivations, conceptions and previous knowledge, which will largely determine the nature and quality of learning which takes places. David Boud succinctly draws our attention to the central importance of the learner's acts while learning:

> 'ultimately it is only the decisions which learners make about what they will or will not do which actually influence the outcomes of their learning.'
> [Boud, 1981]

Either of these broad theoretical positions may inform the the teaching decisions made by individual teachers, or indeed the design decisions made by designers of learning materials or activities. Argyris [1976] drew attention to the difference between espoused theories, that are expressed as the theories underlying practice, and theories-in-use, which are the actual, unexpressed theories which guide practice in reality. Espoused theories and theories-in-use are often different. Although constructivism is now the dominant espoused theory in higher education, it is possible to see in current practice, including the design of many learning activities using C&IT, that objectivism is still the dominant theory-in-use. Biggs [1996] reminds us that professionalism requires the espoused theory to be the theory-in-use.

For the purposes of evaluation it is important to understand that the stated intentions underlying the innovation may not reflect the actual theory-in-use, and that a product which aims to develop students' understanding might have been designed with an objectivist approach. Such a product is unlikely to be successful in achieving appropriate aims.

The commonly stated aims of learning in higher education are closely associated with a constructivist approach. That is to say that what is said to be valuable in higher education is something more than the simple acquisition of skills or accumulation of knowledge. Academic learning at tertiary level is believed to be fundamentally about the development of understanding and the ability to apply critical judgements to presented knowledge. It aspires to the position in which students construct their own maps and networks of meaning, testing them against principles and descriptions by others. Particular skills and elements of knowledge might play significant parts in the construction of this personal understanding, and will need to be mastered by the learner, but these will be means and not ends in themselves. And such skills may be better achieved when their development is closely integrated with associated conceptual learning. (As an example, the reason that we wish science graduates to be skilled in laboratory techniques may not be so much that those skills will be of applied value in later life, but rather that by gaining the skills the learners are enabled to further develop their knowledge and understanding).

The implications of this are that learning technologies, like other teaching situations, should be evaluated as to the degree to which they encourage or facilitate the development of understanding. The exceptions to this might be learning programmes whose sole aim is skill development.

The development of understanding is a complex process, and its outcomes have been typically difficult to identify and classify. However, the work of Biggs and Collis [1982] has provided a powerful taxonomy, The Structure of the Observed Learning Outcome or SOLO taxonomy, and this might provide a useful tool to assist the evaluation of learning technologies.

SOLO and levels of learning outcome

The SOLO taxonomy provides a systematic way of describing a hierarchy of complexity which learners

show in mastery of academic work. The taxonomy, arrived at through phenomenographic research, is intended to be and has been successfully applied as, a description of the range of performances produced by learners in attempting a particular academic activity, and its particular strength is its generality - that is it is not content dependent, and it may be used effectively across a number of subject areas (see for example case studies in Gibbs [1993]).

SOLO describes five levels of sophistication which can be encountered in learners' responses to academic tasks:

- Prestructural - the task is not attacked appropriately, the student hasn't understood the point;
- Unistructural - one or a few aspects of the task are picked up and used (understanding as nominal);
- Multi-structural - several aspects of the task are learned but are treated separately (understanding as knowing about);
- Relational - the components are integrated into a coherent whole, with each part contributing to the overall meaning (understanding as appreciating relationships);
- Extended abstract - the integrated whole at the relational level is reconceptualised at a higher level of abstraction, which enables generalisation to a new topic or area, or is turned reflexively on oneself (understanding as far transfer and as involving metacognition).

[Biggs 1996]

Levels 4 and 5 can be seen to be qualitatively different from the lower levels, in that both 4 and 5 involve the learner in integrating the new knowledge and skills into a coherent structure. The learner is making meaning. It is learning at this level which is characteristic of effective learning in higher education, and is the desired aim of most established programmes.

This provides a possible approach to evaluating the effectiveness of learning and teaching situations for facilitating students' understanding: if evidence of higher SOLO levels can be found then it suggests that the learning activity is effective at encouraging the construction of knowledge. Absence of evidence might suggest that something in the design or implementation of the learning activity is in need of improvement.

There are two important problems to be overcome with this approach. Firstly there needs to be an effective way of identifying the different SOLO levels of outcome which students achieve. It is not enough to rely on assessment results to indicate these, since that presupposes that the assessment scheme is designed to measure, or actually does measure, the level of understanding. This is by no means common (nor unproblematic). It is unlikely that assessment by multiple choice questions is effectively measuring the level of understanding, for example.

The most fruitful route to gathering this data is by analysis of students' written work, using a protocol based on the SOLO taxonomy. With experience and sensitivity this can provide evidence for reasonably robust judgements about the level of understanding being achieved, independently of the content. Alternatively analysis can be made of students' reflective written or verbal reports of their learning activities, elicited for example by interview (eg case studies in Gibbs [1993]) or in learning journals. Biggs [1996] provides a starting point for the development of an evaluative protocol, focussing on the *effect* of understanding: if you understand something properly you act differently in contexts involving the content understood. Biggs proposes a hierarchical list of 'performances of understanding', from most desirable to barely satisfactory using SOLO as a baseline. As a performance measure the list focusses on verbs. An example based on a particular unit in a BEd programme at University of Hong Kong provides this example of a descriptor for the Most Desirable (extended abstract) performance:

> 'metacognitive understanding, students able to use the taught content in order to reflect on their own teaching, *evaluate* their decisions made in the classroom in terms of theory, and thereby *improve* their decision-making and practice. Other outcomes: *formulating* a personal theory of teaching that demonstrably drives decision-making and practice, *generating* new approaches to teaching on the basis of taught principles and content'.
> Biggs [1996]

It is interesting to compare this with a descriptor for level 3 Moderately satisfactory (multistructural):

> 'students understand declaratively, in that they can *discuss* content meaningfully, they *know about* a reasonable amount of content, but don't transfer or apply it easily'.
> Biggs [1996]

In summary, a performative picture of

understanding offers a way in which teachers and designers of learning technologies can develop means of judging the level of students' learning in particular contexts.

The second problem to be addressed is a larger one; so large in fact that it cannot be adequately treated within the scope of this paper, beyond drawing attention to it. A constructivist view of learning, as noted above, recognises the central importance of the learner and the significance of the context on learning. Consequently any evaluation of particular teaching methods or learning technologies is fraught with difficulty - the effectiveness will vary, depending on the scope of previous knowledge, attitudes, and conceptions which particular learners bring to the learning situation, and the larger context in which the learning situation is embedded. The outcomes of a particular evaluation of learning effectiveness cannot therefore be easily transferred out of the context in which the evaluation occurs. Evaluation of learning technology must be situated in the context in which the technology is used. In effect this is to say that evaluation of *implementation* is unavoidably needed, and that the judgements made by evaluators may say less about the design and more about the implementation of the technology in question. And this is entirely appropriate, of course. Effective learning has often arisen from a bad book introduced at the right time.

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A Diet of Carrots: Autonomy in Learning Mathematics for Economics

Robbie Mochrie, Heriot Watt University

Abstract

The teaching of mathematics to economics students is a core component of all degree courses. Many students report acquisition of the necessary mathematical skills and their application to economic theory to be one of the most difficult and unsatisfying parts of their courses. Teaching this material is made particularly difficult by the variation in students' prior knowledge, confidence and motivation to study this material.

At Heriot-Watt University, we have started to develop computer based learning systems which we hope will eventually provide students with sufficient incentives to learn mathematical skills more effectively. In the first phase, which ran this year, we used the University's WebTest engine to write a mathematics test each week. All the test questions contained many randomised parameters, so that successive realisations would certainly be quite different. This allowed us to give students credit for successfully completing the tests, while allowing them as many attempts as necessary to pass.

Student response to the tests has generally been favourable. WebTests appear to have been successful in encouraging students to keep working at developing their mathematical skills and this is reflected in examination marks. Problems have arisen because of difficulties in inputting answers, reflecting the need for staff as well as student learning, and because of the inadequacy of feedback, The second phase of the project, which will involve the conversion of the present module lecture notes into more accessible hypertext documents, is intended to allow much more complete linkages between tests and other elements of teaching, and to increase students' autonomy in learning.

Introduction

Before commencing a discussion of my use of computer aided learning in economics, I should like to tell an anecdote that I consider to be quite instructive. A friend, who is a technician in a medical laboratory in one of the larger teaching hospitals in this country, tells me that much of the time the medical staff are unable to diagnose the cause of patients' ailments. So he is sent various samples of tissue and such like to determine whether there is anything abnormal. Treatment in such cases then reduces to alleviation of symptoms and signs and so the primary concern of the medical staff is to "stabilise" the patient's condition so that these signs are "normal." My friend's suggestion is that very often medical staff are more concerned to with ensuring normality than with patients' survival, so that a perfectly acceptable outcome appears to be death, but with normal indicators.

I find myself wondering to what extent such problems are to be found not only in medicine, but also in the appraisal and evaluation of teaching innovations. What I have just described is familiar in the literature upon student teaching, where such behaviour would be considered to reflect shallow and atomistic learning. In general, it is considered appropriate for teachers (certainly in higher education) to encourage deep, holistic learning, involving the evolution of students' conceptions and the integration of knowledge within a coherent framework. Yet here we are at this conference, pulling out from the various learning activities in which we expect our students to engage a single one, and seeking to evaluate its effectiveness in isolation. I do find myself wondering whether in doing this, we are like medical staff facing a condition that is too complicated for them to understand fully and responding to individual effects rather than analysing the system as a whole from the very start. In particular, I wish to suggest that there is an inevitable tension between short-run success in teaching and long-run success. In short, it is not enough for us to say that an innovation has been successful because students have completed assessments satisfactorily, or even that they indicate approval of the innovation in surveys. These are means of eliciting surface information. It may be necessary to embark on action research programmes in order to identify the extent to which learning has actually taken place.

I hope that you will bear with this rather pessimistic outlook, which is the result of my being in the middle of developing an innovation. As I hope to show this afternoon, the innovation that I have developed along with Andy Crofts of the Teaching

and Learning Technology Service at Heriot-Watt University has been successful in many respects. I am quite certain that more students in the economics class are learning more mathematics as a result of their exposure to this innovation. Yet I am also concerned that the form of the innovation has led to students concentrating excessively upon problem solving and that this has limited their ability to transfer the skills that they develop in the environment of the computer based learning to more general economic analysis.

Having started out by stating that it is very important for us to consider the objectives of teaching in order to evaluate its effectiveness and also that it is important to consider the effects of all teaching, it seems sensible to work from the most general aspects to rather more specific ones. I suggest that all non-vocational higher education seeks to help an individual to locate a personal reality in which there is scope for conflicting opinions, but which nonetheless rests upon a set of coherent beliefs. To be slightly less obscure, learning in higher education is associated with the development of critical faculties and the ability to respond to arguments by considering the premises on which they are established and the evidence supporting them. The concepts contained in those last statements are very important and certainly controversial, Western philosophers having sought to clarify them since the time of Socrates. I therefore do not intend to attempt to unpack them further today, but instead turn my attention to the particular discipline of economics.

It seems reasonable to say that most academic economists have developed a particular way of thinking about their discipline. While disagreements among economists are sufficiently famous to have been recorded in witticisms such as "If all the economists were laid end to end, they wouldn't reach a conclusion," nonetheless such disagreements tend to relate to controversial areas at the frontiers of the discipline. In the areas where undergraduates are studying, there seems likely to be much greater consensus, certainly concerning the ways in which questions might be approached. The starting point of most economics is the assumption of rational self-interest, an instrumental concept of rationality in which people seek to achieve their own ends, however those might be defined. In addition, economists ordinarily assume that demands are insatiable and that markets work in allocating scarce resources among these demands. The discipline that develops from the interconnection of these core beliefs is based on the study of equilibrium within elegant models for which precise mathematical representations exist and numerical approximations abound.

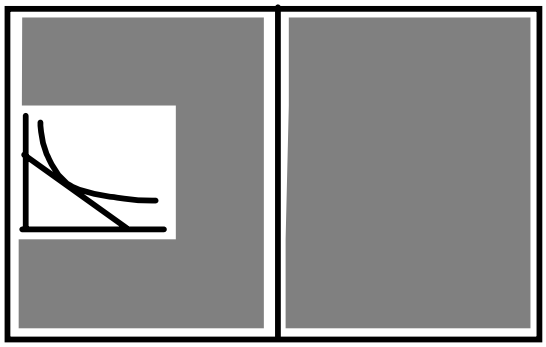

Figure 1

There is a problem here. Students who do not possess the ability to understand the algebraic representation of simple models and the analysis that leads to the derivation of the equilibrium for that model will find it very difficult to follow the arguments presented at the higher level of a degree course. Equally, students' introduction to economics does not prepare them fully for this treatment of the subject. Let's consider just how quickly this change takes place. In *Figure 1* we see a schematic presentation of one of the fundamental building blocks of economic analysis, the problem of how a consumer chooses between two goods in order to maximise utility, as it would be shown to first level students. Central to the presentation is the diagram, and surrounding the diagram is solid, dense text. For the student to understand the material, the student has to be able to understand what the various curves and lines represent and interpret the relationships between them. Now I do not want to denigrate such an approach, for as recently as fifty years ago, most students probably would not have needed to undertake any more sophisticated analysis at any stage of their studies and there are undoubtedly many sophisticated results that can be obtained from this form of analysis.

But now let's look at *Figure 2*, which is a schematic representation again, this time of the first chapter of one of the more advanced of second level microeconomics textbooks. Now I am cheating somewhat here, for on the preceding page, there is indeed a similar, if briefer, analysis based around the diagrammatic representation. But I think that it is instructive nonetheless that the authors of this book from its very start assume that it is appropriate to present a problem of constrained optimisation, assuming understanding of the Lagrangean multiplier technique of solving this

problem as well as understanding of the concept of the total differential, matters that would not be familiar to the majority of students whose study of mathematics had ended at A-level. Such a presentation is problematic. Imagine for a moment that you are a second year undergraduate who considered passing GCSE mathematics to be something of an achievement and escape from mathematics at A-level to have been a great relief. Suddenly you are presented with arguments such as

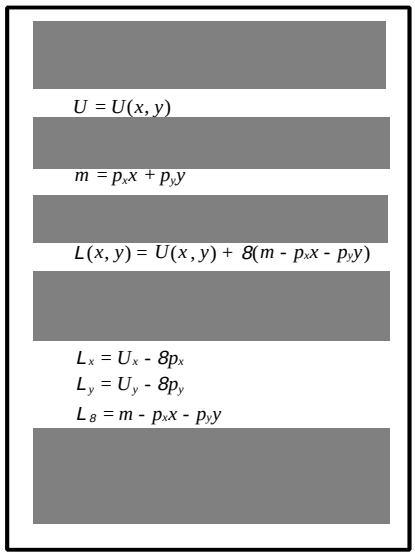

Figure 2

this. My feeling is that your perplexity would lead to anxiety or even to panic. Your response would either be to try to learn the equations symbol by symbol, as though mere reproduction would be a good enough imitation of learning to pass an examination; or else you would pass on as quickly as possible to the point where the mathematical form of argument concluded. Although the latter is much more likely, the former certainly occurs. Equally, suppose that you are a student with a strong mathematical bent, but who has not previously met the Lagrangean multiplier condition. Here there is another danger, that you work through the mathematics listlessly or independently. Noting the effort that your teacher makes to drill others in the class in the technical aspects of the argument, you do not develop the economic logic that underlies the technical argument. Being honest, this was my experience. The time that I first really had to confront this material and understand how all the components of it locked together was when I came to write lecture notes upon it. Which does raise some interesting questions: in particular, if it is possible for a capable student to pass through a first degree with a severely impaired understanding of such key concepts, how do weaker students fare?

These comments provide an indication of the difficulties faced by an economics lecturer attempting to teach mathematics. I have described above paths that are likely to lead to surface learning, rather than deep learning, so that students grasp facts and do not perceive concepts. In addition, however, we must consider students' orientation. I suggest that for most students, the only source of motivation to study this material is academic: the social, the vocational and the personal are likely to be absent, even though econometricians (economists who use statistical analysis) are probably one of the best paid groups of professionals in the country. More importantly, however, I suspect that most students see mathematics as an external imposition. It is one of the hoops through which they must jump in order to complete the requirements of their course, not something that they wish to master chiefly in order to understand it, or even because they see it as being an essential building block in their understanding of economics. Even worse, there are some students for whom mathematics is simply something that is happening "out there", who avoid contact with it as far as possible, whose prejudice against their own understanding is so great that their orientation towards the material never really develops.

What we are trying to do at Heriot-Watt is to provide students with incentives to develop their orientation towards the principles of mathematics. This is still work in progress and our thinking has developed as students have interacted with the new material and we have had the opportunity to reflect on their performance. We started by identifying the problem as being one of students not developing sufficient familiarity with essential techniques early on, so that confronted with economic applications of these techniques from which important principles of economics could be deduced, they were unable to respond effectively. We thought that it was likely that the students were having difficulty in seeing the woods from the trees. For example, a student who is expending considerable effort on obtaining the reduced form of a system of equations is probably going to be sufficiently exhausted by that effort as to be unable to perceive economic interpretation of the reduced form parameters. We concluded that students will find many ways of avoiding mastery of these techniques unless they were in some way compelled to confront this material at an appropriate time.

Economists tend to be fully paid up behaviourists. It therefore seemed perfectly reasonable to us that

students would only do what we wanted them to do if we provided them with adequate incentives in the assessment scheme. We wanted to assess students regularly, but without making the assessment procedure threatening. Continual examinations, quite apart from requiring resources that would not be available, would therefore be impractical. Setting course work assessments completed without supervision permits collusion and direct copying that is very difficult to detect. However, it did seem possible to use the WebTest engine developed by Maureen Foster in the Department of Mathematics at Heriot-Watt University. Relying on the programming skills of Andy Crofts, the development officer in TLTS, we set up a sequence of fourteen tests, which the students completed over the first two terms of this academic year, all of them introducing students to application of mathematics to economics.

What we particularly liked about the WebTest engine was its versatility. Students only required to be able to access a web site in order to be able to generate a test. Because questions contained multiple random parameters, there were generally thousands of possible variants to each of the questions that might be asked, so each test generated was almost certain to be different from all of the other ones. Generally answers were numeric, so that students had to perform a calculation, usually one involving two or three steps and then type the appropriate numbers into the boxes on the form. However, it was also possible to use multiple choice questions and the variety of formulae that we could use increased as the engine was developed over the period that we used it. Students completed the tests by typing in the text boxes on the form. Having completed a test, it could be submitted for marking immediately and the score returned to the students on a form that had the correct answer together with hints concerning the way to find the solution.

Each test required the students to answer ten questions. In order to encourage students, these questions were of differing difficulty and it was generally possible to answer the first two or three with only the most basic knowledge. However, in order to encourage students to keep working at the material, we used a binary marking scheme. In order to pass a test, a student had to answer seven out of the ten questions in a particular test correctly. Students who passed received a credit of 1.5% of the mark for the module to which the test was attached, so that it was possible, without fully completing the tests, to obtain the marks for the test. However, the mark of seven out of ten was intended to ensure that students earned their marks, demonstrating a good understanding of the material covered in the process. To encourage students to take risks, they were allowed as many opportunities as they required to attempt the test. Most sought no more than three unsuccessful ones, with marks tending to increase quite quickly to the pass mark. Over half of the students completed all of the tests in the second term and this ensured that they entered the final examinations able to perform quite badly, yet still pass. As we shall see, this was just as well.

At first, we set ten separate questions, but as time went on, we were able to ask questions that had multiple parts and which examined a particular question of economics in a number of ways. Throughout, the questions sought to apply mathematical techniques to economic analysis in an attempt to encourage students to look beyond the manipulations and to reflect upon what they were doing.

Andy and I worked at very high speed in order to prepare the number of tests required. This led to a number of technical glitches and on one occasion to my placing on the Web a test which had a major error in one of the answers. However, this was noticed almost immediately by some of our more diligent students and rectified very quickly. We were surprised by the infrequency with which comments were directed to us concerning the tests and certainly Andy Crofts had found other classes much more demanding in seeking guidance and assurance about the use of of the tests. To some extent, we attributed this to the tests being used right from the very start of the academic year, so that students simply saw this as being the way in which they were to study mathematics. Other projects that had used WebTests had only introduced them as pilots during the middle of modules, so that students might already have developed approaches to learning the material that were not consistent with the methods expected by the developer of the WebTest.

The impression that we formed during the working of the tests was that students were broadly satisfied with them. When we carried out a survey of the students early in the second term, we found a more mixed response than we had expected. Dealing with a class where the majority of students had not studied mathematics beyond GCSE, it should have come as little surprise to us that relative few of the students were regular computer users. The WebTests were seen as being very flexible to use, although only a small number obtained access from

outside the university. Twenty eight of the forty students surveyed had completed all or most of the tests, which suggests that the sample was biased slightly towards the better students. Most students claimed to be spending three hours or so on the tests, which was about the level expected and requiring two or three sessions to complete the test, which was also pleasing since it suggested that students were having to work quite hard in order to complete the tests, but were managing this in what seemed to be a reasonable time. There was considerable evidence of group working, which is commendable, although quite a number of students did specifically mention that having worked with others to work out how to answer the questions, they then completed the tests on their own, which is probably the ideal. The preferred mode of working therefore appears to be to generate a test, submitting it blank to obtain answers and hints, printing these off and taking them away to work on. To some extent, this may have led to attempts at backward induction, with students knowing what the answer was to a particular question to working back from the answer to the question.

We found that there was concern over the lack of feedback with the answers. All students learned from submitting a wrong answer to a question was that they had answered it wrongly. They did not receive any hints concerning the ways in which it was wrong and with many of them determined to continue working at questions until they solved them, there was some feeling that they were working too long at the tests. There was also some feeling that questions were badly worded and concern about the "mistakes" in the tests. This puzzled us, since most of the questions had been carefully designed and tested by us before being made available to the students and certainly contained no errors so far as we could see. It turned out that the problem was to do with the formulation of the questions and the ways in which answers had to be submitted, which appeared to be insufficiently flexible. Insofar as was possible, we sought to remedy these matters in the remaining weeks of the course and later exercises suggests that students found the relatively simple change that were made to be quite helpful in using the tests.

By the end of the course, most students agreed that WebTests had helped them to work more consistently, considered computer aided assessments to be a useful way of exploring a subject, and that the WebTest had helped them in applying mathematics to economics, but were still concerned by the limited feedback. They considered that the most effective technique was to print off a test and then to work as part of a group in order to obtain the answers, reckoned that it was important to keep up with the tests and other work in the course, rather than trying to complete them in a rush at the end of term, but thought that it would be much easier having a maths A-level in the first place. So, all seemed to being well. The tests had been completed, and most students had obtained very satisfactory credits for completing the material. This suggested that whereas students had in the past failed to continue working at the material throughout the two terms, they had been persuaded, possibly by the lure of easy marks, to do so in this way. It was therefore very disappointing for us to mark the examinations at the end of the second term and to discover that the majority of students had done very poorly in the mathematics questions. In all too many cases, there was little evidence of any learning at all, and there appeared to be very little difference between the results this year and in previous years. We have explored some of the reasons for this with Prof. John Cowan, formerly of the Open University in Scotland. He has suggested a methodological flaw in the work as it stands and is concerned that there is too much emphasis upon numerical testing and problem solving. In other words, we give students marks during the year for learning and applying one set of skills, but these are only a subset of the ones that we wish them to acquire. Professor Cowan's suggestion is that we should link the WebTests more explicitly to the rest of the course and that we should encourage students to abstract from what they are learning in the WebTests, so that they are able to identify concepts that they are able to use elsewhere. The proposal that he has made is that we should allow students to prepare cards on which they would write down guides to techniques of problem solving, allowing them to take these into examinations. In other words, we would recognise the limitations of the WebTests. Excellent though they are for encouraging students to keep on working away at particular kinds of problem, they are probably insufficiently flexible by themselves to encourage the reflection necessary for deep learning. As a tool, they have already proven themselves, increasing students' independence and in many ways also their effectiveness as learners. As we integrate other material with them, particularly a course hypertext, they will no doubt become even more valuable resources. Indeed, the lesson to take from this experience may be that in order to make such a substantive innovation, it is not possible simply to bolt it on to the course as we did with the WebTests, but to consider much more carefully how it relates to other components of the course. Given that the students are likely to do most

of their learning in the context of these tests, other aspects of the course, such as lectures, tutorials and even examinations should perhaps be redesigned with the use of WebTest in mind.

The URL of the web site that was used for setting up the test is http://flex-learn.ma.hw.ac.uk

Evaluating the Use of Computer Mediated Communication Resources by Trainee Educational Psychologists

Andy Tolmie, Jim Boyle & Ingeborg Stobie, University of Strathclyde

Background

The MSc in Educational Psychology at the University of Strathclyde is a two year course providing British Psychological Society accredited professional training for (currently) 12 people. The trainees are honours graduates in psychology, and in the main have three to four years experience of work with children, young people or families, in most cases via teaching or research. The course is delivered via a combination of lectures, seminars, tutorials, group and individual project work, and practice placements. Lectures, seminars and tutorials take place during the two days per week when trainees attend the university. A further two days per week are spent on individual placement in schools and Psychological Service offices across central Scotland, where trainees begin professional work under the supervision of "practice tutors".

In the past, preparation for seminars and for group project work has been to some extent constrained by this division of time. Since for much of the week the trainees were physically remote from each other, if they needed to collaborate or to seek guidance from course tutors they had to rely on meeting whilst in the university (despite the tight scheduling of this time), or else make do with telephone calls. Thus it was clear that enhanced support for trainee learning could be achieved by developing the use of e-mail and online conferencing for remote communication with tutors and peers, and by providing remote links to library facilities and WWW resources. Introduction of this element to the course would serve in addition to promote the acquisition of generic, transferable IT skills which would later be valuable to trainees and to the profession when they became practitioners. For instance, educational psychologists in Scotland have for some while had a dedicated electronic conferencing system, although this has been little used other than for specific development projects. If trainees were already experienced in this mode of communication when they qualified, they would be able to make better use of such systems, and would also carry the culture of online contact into Service offices.

Implementation

A new intake onto the course for the 1997-98 session provided the opportunity to attempt to achieve these objectives, and from early 1998 trainees were given access to a dedicated *FirstClass* e-mail and conferencing system. This operates via networked machines within the Psychology Department at Strathclyde and modem links in Service offices, and allows users to post messages to either a shared discussion space or an individual's personal mailbox. Whilst the conferencing system formed the cornerstone of the new facilities, access was also provided to internet resources, including Netscape and a course web site. *FirstClass* 3.5 was selected for the e-mail system after a survey revealed that this version of the software, together with connections to a coordinating server (run by the Scottish Council for Educational Technology), was readily available out in the field to eleven of the twelve trainees on the course. *FirstClass* also had the advantage of providing the trainees with a relatively transparent graphical user interface and a range of menu-driven facilities. These were important considerations given that, despite their likely strengths as effective face-to-face communicators, this cohort of trainees was not experienced with *computer-based* communication systems. In fact only three of the group of twelve had used e-mail previously at all.

The introduction and embedding of the *FirstClass* system into the course took place gradually. Shortly after commencing in October 1997, trainees were shown examples of e-mail and conferencing facilities, and were introduced to the idea of using these for course-related communications. Some of the advantages of doing so, both for aiding current activity and for learning generic IT skills, were pointed out to them, and the introduction of such a system into the course was discussed. It was suggested that if it was introduced, it would be desirable to monitor the usage and impact of that system, in order to establish whether it was being effective, and if it might be improved upon. This monitoring was something to which they were asked to give explicit consent.

After the trainees' agreement had been obtained, and a variety of software options had been considered, a "closed" discussion group (i.e. accessible only by the trainees, course tutors and project consultants) was finally set up on the SCET *FirstClass* server. Specific training in the use of *FirstClass* was then provided within the university, backed up by copies of paper-based guidance notes. Trainees were encouraged to check their connections to the conference from their respective Psychological Service offices, and were offered assistance, if necessary, in installing software and setting up modem links correctly.

Due to networking and software problems, the cementing of field connections did not in fact proceed smoothly. Five weeks after the system had been set up, only eight of the twelve trainees were fully online. For two of them, problems persisted for a further five weeks after that.

Whilst attempts were made to resolve these various problems, those who could access the *FirstClass* facilities were left to make informal use of them for contacting course tutors and each other. In the meantime, the course tutors, with the assistance of an LTDI Project Consultant, identified and mapped out in detail activities which lent themselves to computer mediated conferencing and which could be integrated into the course. The intention here was to provide the trainees with clear incentives to engage with the resources now becoming available to them. Thus approximately one month after the conferencing system had been set up, trainees were divided into two groups of six, and set the task of working collaboratively within these groups to produce a seminar paper on an assigned theme, making use of e-mail where appropriate. For each theme, details of key readings (three papers) and four to five 'starter' web sites were made available by tutors. Each group was to review the materials relevant to their theme and produce a briefing paper of four to five pages containing an overview and critique of previous work, together with guidelines for professional practice. This paper was then to be discussed at a face-to-face seminar.

Initially, the intention was that the first group (Group One) would be allowed three to four weeks to prepare their paper, and that following the face-to-face seminar that paper would be subjected to a critical peer review by the second group (Group Two). The roles would then be reversed, and Group Two would move on to prepare their paper. However, the time required by the Group One to complete their draft was almost twice as long as had been anticipated by tutors, and it became plain that it would not be possible to undertake the peer reviews within the time frame originally envisaged. The sequence of work remained as planned in other respects though, with deadlines for Group Two being about one month after those for Group One. In addition to the seminar tasks, trainees were encouraged to use the conferencing system to collaborate on their small group (foursome) research projects on school-based reading intervention.

They are expected to use it further to prepare a poster for a professional conference later in the year.

Evaluation

As McAteer et al. (1997) and Warren & Rada (1998) point out, there are a variety of potential foci for evaluation studies of resources like the trainee conference. Implicitly or explicitly, the objective of such studies is not simply to determine whether a resource "works" or not, but to isolate as far as possible the factors that contribute to success or failure. Which factors are chosen for attention in any particular instance can be argued to reflect, broadly speaking, one or more of three main areas of concern: the C&IT systems approach focuses on the effects of the resource or system itself; the individual differences approach is concerned with the influence of individuals' attitudes, experience and capabilities; and the human relations approach focuses on relationships between users and how they work together.

In the present case, the size and nature of the trainee cohort and the use of a well-established "off-the-peg" system militated against the individual differences and C&IT systems approaches. Whilst care was taken to establish what prior experience the trainees had had with e-mail and other online resources, the group was too small and highly selected to display much readily measurable heterogeneity. In fact, outside of their lack of past experience with e-mail, previous literature indicated that the trainees had all the characteristics of task-related expertise, motivation and awareness of goals that would predict a successful implementation (see Tolmie & Barbieri, 1997; Tolmie & Anderson, 1998). Similarly, whilst much thought went into the choice of system, the selection of *FirstClass* was guided not only by its availability, but also by a range of literature indicating a high degree of suitability to the circumstances in hand (see e.g. Wilson & Whitelock, 1998).

In a sense then, the issues of interest here were inevitably those most closely identifiable with the human relations approach, but this was not the case simply by default. From the outset, the intention was to set up a resource that was likely to be well-used, as far as could be judged, with evaluation work primarily focused on how well the system fitted into the *context* of usage, as gauged by its capacity to support task-related interaction amongst a group of skilled communicators. The methods employed to conduct the evaluation were selected specifically to address particular questions deriving from this concern. A description of these methods, together with preliminary results, is laid out below question by question.

1) How receptive were the trainees to the introduction of the conferencing system?

Despite the range of indicators pointing to the likely success of introducing the selected system into this particular course, if the trainees were resistant at the outset, or felt that these developments had been imposed upon them, they would be unlikely to use it. For this reason it was considered important that introduction of the system be accompanied by a process of negotiation, as noted previously, and that the effects of this process be carefully monitored, as far as was possible. To this end, **written records** were kept of the early meetings where the introduction of the conferencing system was discussed, and of the trainees' reactions during these.

Some outline of the introductory meetings has already been given, but to enlarge on this, the idea of using e-mail and conferencing facilities as part of the course was first mooted by the course director at the initial e-mail demonstration, prior to trainees commencing their placements. The potential advantages highlighted at the time were benefits for course administration and group project work in terms of ease of communication; the capacity to generate jointly written material, including that needed for presentation at the annual professional development conference; the possibility of contact with trainees on the parallel course at Dundee University, and with other professionals; and the chance to gain experience of the use of resources of this kind. As far as monitoring of use of the system was concerned, it was stressed that the main objective would be to identify any improvements to the system needed for Year 2 of the course. Trainees were told that this monitoring might involve the completion of questionnaires and logs of activity, and also inspection of online messages, but only with their agreement.

Reaction to these suggestions was somewhat cautious, especially as regarded the issue of monitoring use of the system, and the trainees requested further information on this point. Thus a second meeting of the group with one of the project consultants was arranged. Here it was explained that past research indicated that many factors affected whether educational conferencing systems worked, but also that when they did they provided an important avenue for productive discussion and exchange of information. For these reasons it was helpful to check the operation of such systems when they were up and running, however much thought had gone into their set up. It was stressed that any intrusion and extra work involved in making monitoring possible would be kept to a minimum, and that as already indicated, online messages would not be inspected without consent.

Concerns were still expressed at this meeting about the possibility of use of the conferencing system involving extra work on top of an already heavy load; and conversely, whether the group would actually find things to use the system for, and if they did, whether the benefits would be available to everyone. However, after an interval of a couple of days the trainees expressed an overall favourable opinion towards proceeding with the idea along the lines suggested. On this basis it was decided to set the system up, and provide time for the trainees to explore it before setting specific tasks that might require its use. The fact that the trainees did take time to consider actively what might be involved and whether it would be of benefit to them, rather than simply acquiescing straight away, was felt to be an indication of the likely emergence later on of at least some sense of ownership of the system, and thus a further sign that a successful outcome was probable.

2) What was the pattern and content of the online interaction, how dependent was it on task characteristics, and how far did it differ from off-line interaction?

Having decided to set up the conferencing system, the next concern was how it bedded down in the course, what functions it served, and whether these were novel or if it simply supplanted other means of achieving the same ends. In short, was the system acquiring a distinctive role, and was it effective in serving that role?

A variety of methods were used to address this issue. The first involved **observation of a face-to-face seminar** prior to the setting up of the system, in order to gain a picture of the trainees'

communicative styles and capabilities when dealing with course-relevant material under more standard circumstances. The seminar chosen was the last prepared without potential e-mail support, or allocation to task groups, and focused on secondary schools' policy and organisation with regard to Psychological Services. The observation tended to confirm the anticipated sophistication of the trainees' face-to-face communications. There were some differences in expectation about how formal the session was supposed to be, some having come armed with overhead slides and prepared talks, others just with notes. However, over a two hour period there were lengthy contributions made by almost all present, although since each had been working in a different school they had different information available, which was probably helpful. What was striking, though, was the incidence of spontaneously organised floor-shifting, without direction from the tutor present: those who had not yet contributed would typically pick up on a point from the previous speaker, develop it and carry it on into their own mini-presentation.

The second major source of information with regard to the issue of interaction was the **online messages** themselves. Three methods were used to inspect these: a) a simple count of the **frequency** of the messages, in relation to the tasks which had been set; b) an examination of the **relative contribution** of different course members; and c) coding of the **function and length** of messages. Taken together, these provide a picture of online communication patterns during the first months of operation of the conferencing system.

Looking at **message frequency**, a count of messages per week after start-up showed a small flurry of activity for the first four weeks (on average about five messages per week were sent to the shared conference space), as those who were able to gain access tried out their connections. This subsided to an average of one message per week for the next four weeks, despite the Group One's seminar task having been set, although this was explicable in part by the period coinciding with the Easter vacation. Over the next four weeks message frequency climbed sharply to a peak of 20 per week, as the remainder of the trainees established connection, Group Two's seminar task was set, and Group One finalised their paper for the face-to-face seminar. The subsequent four week period, leading up to Group Two's face-to-face seminar saw a drop in frequency to around three messages per week. The period after that, leading into the summer vacation, saw a further decline to, on average, one message per week.

All in all, then, there was a clear coincidence between online activity and the group seminar tasks, especially in the periods immediately prior to the face-to-face sessions, although this trend was more marked for Group One than for Group Two. As hoped, whilst it was not necessary to use e-mail for the seminar tasks, the indications were that it had to some extent proved helpful to do so. It is perhaps worth noting that this is consistent with previous literature suggesting the importance of clear tasks for the use of CMC in educational settings (see Tolmie & Barbieri, 1997).

Turning to the examination of the **relative contribution** of different members of the course, the data both confirm and qualify the apparent impact of the seminar tasks. In the first place, use of the shared conference space varied widely across the trainees, from no contributions at all in two instances, to a maximum of 24. Overall, taking initial connection problems into account, only five of the twelve trainees could be classed as regular users (i.e. those who made a reasonable number of contributions, spread over a period of time). Having said this, however, the number of contributors did tend to increase in response to work on the seminar tasks, although there were further distinct differences in this respect between Group One and Group Two: for the former, four out of the six group members became regular contributors for at least the period preceding their face-to-face seminar; for the latter it was three at most, and then only very briefly.

This was, on the whole, unexpected. Whilst variable participation rates and 'lurking' are often regarded as the norm in the CMC literature, in fact participation rates amongst small groups at this level of expertise are usually much less patchy, especially when they have a clear task to work on (see Tolmie & Anderson, 1998). The pattern here also stands in some contrast to the observed participation in the face-to-face seminar reported on above. There would seem, on the face of it, to be two possible explanations. The first is that the trainees, for the purpose of the seminar tasks at least and for whatever reason, genuinely divided into "movers and shakers" on the one hand, and "lurkers" on the other, and these were not evenly distributed across the two groups. Consistent with this, one member of Group One did explicitly acknowledge lurking tendencies in a message to the conference! However, it seems unlikely that this lack of engagement extended to all aspects of the task, not least because it would have been markedly out of line with the trainees' other work, but also because

there were no signs of the claims about "passengers" which would typically accompany this pattern.

The alternative, then, is that all group members were contributing to the seminar tasks (and other activities) but that some were doing so outside of the online conference. If so, it would be valuable to identify why. It should be noted, however, that there is one straightforward possibility to be taken into account. For the purposes of examining online interaction, only the trainees' messages to the *shared* conference space were available. Messages relevant to the seminar tasks may therefore have been sent via the *private* mailboxes in some instances (there were no instructions to use the shared conference), but these would not register in the contribution count. Indeed there were indications that in general much mail was sent this way: around 10% of the shared space messages appeared to be direct responses to private box mailings.

Coding of the **function and length** of the messages to the shared conference space helped to fill out further the gradually emerging picture of the character of the online interactions. First of all, there was confirmation of the impact of the seminar tasks: during the eight week period covering the lead up to the face-to-face seminars for Group One and then Group Two, there were only two weeks when communications relevant to the seminars were not amongst the most frequent categories of message, and average message length jumped during this period from 1K to 8K. Two further points are relevant here. This first is that when this pattern is taken alongside that of actual message frequency, it becomes apparent that whilst Group Two apparently tended to make fewer online contributions during the weeks preceding their face-to-face seminar, the characteristics of the messages they did send were similar to those sent by members of Group One during the corresponding period. In other words, e-mail was serving the same *type* of function for both groups, if not to the same extent. The second point is that closer examination of the seminar-relevant messages shows them to be a two kinds: brief exchanges of information, or lengthy attachments of drafts of sections for the seminar paper with requests for feedback (hence the jump in message length). The conferencing system did indeed seem to be serving a distinctive function then, at least in respect to the seminar task, but this in no respect paralleled face-to-face style discussion - making any departure from face-to-face patterns of contribution less remarkable perhaps. It is worth noting that use of the conferencing system to support joint writing was one of the possible functions highlighted during the introductory sessions (see above).

Seminar-related messages were of course only prevalent during the period noted above. The conferencing system was used at other times for other purposes, including, earlier on, group project work, and latterly the first steps towards preparation of the conference poster. Social messages, the seeking of advice from tutors and peers, and course administration messages tended to occur with moderate frequency throughout. In all these instances, information exchange appeared once again to be the primary objective. Overlaying all other messages, however, was one category which had a consistently strong presence throughout: exchanges about network connections or software problems, either pointing up problems and seeking advice; or announcing the solution of problems and the establishing of connections. During 11 out of the 17 weeks from the start-up of the system until the summer vacation this was the most frequent or joint most frequent category of message. In other words, then, all other activity took place against a background of perceived connection problems.

The third source of information about interaction was provided by **logs of contact and activity** which the trainees were asked to keep in relation to the group projects, both before and after the introduction of the conferencing system, and also for the secondary school seminar (i.e. before *FirstClass*) and the two group seminar tasks. These logs simply consisted of proformas for noting down relevant activity, who else (if anyone) was involved, the medium used, and the time taken. The reasoning here was that whilst examining online messages gave some idea about what e-mail was being used for, in itself this provided no information about how e-mail communication fitted into other activity and contact, and whether the latter had changed with the introduction of the conferencing system. The logs were intended to provide this information.

In the event, the logs were less than entirely successful due, amongst other things, to relatively low completion rates. For instance, only three of the twelve trainees completed the log for the secondary school seminar, although this may have been in part because this log was not given out until shortly before the seminar and there were too many other activities competing for the trainees' available time. Moreover, since it had been stressed at the outset that assistance with monitoring of the system was voluntary, trainees were under no real obligation to

return the logs. A further problem with the secondary school seminar log, though, was that this activity was not the best choice as a baseline for interaction patterns prior to the conferencing system coming online. The nature of the exercise meant that work was necessarily more independent than was the case later, and the bulk of the reported discussion was with teachers rather than tutors or peers: only one of the three returned logs reported any contact with other trainees, and this was limited to discussion of the format of the seminar. Similarly, preparation of material for the seminar was in all cases reported to have taken place without any outside contact.

Logs for the two group seminars had a better return rate, and did show a different pattern of activity, but in view of the points above it is not possible to judge how far this should be attributed to the existence of the conferencing system, and how far to the nature of the task. However, comparison between the logs for Group One and Group Two is revealing vis-a-vis the apparent differences between their online activity, and thus indirectly about the impact of the system.

For Group One, four out of six logs were returned, and although there was a degree of variation across these in the time spent on different activities, it is possible to calculate rough means for each, as follows: on average 119 minutes were spent in face-to-face communication, 97 Minutes on e-mail communication (including failed attempts at connection), 12 minutes on telephone communication, and 281 minutes on independent activity (including word-processing and internet access). Consonant with previous literature (see e.g. Lewis, 1997) and with some of the details reported above, face-to-face communication took place more typically at the outset, and at points of negotiation (a pattern associated with successful use of conferencing), whilst e-mail was used more for the exchange of drafts, updating others on progress, and deciding on the format of the seminar presentation. This confirms other indications that although a reasonable proportion of time was spent conferencing (or attempting to), e-mail was used primarily for information exchange, whilst discussion was reserved for face-to-face contact. It is possible that a lack of confidence in the reliability of the online connections meant that it was not trusted for serious discussion; or it may be that because the group had the opportunity for some face-to-face contact throughout, it seemed natural to use the more familiar medium for discussion.

For Group Two, only two out of the six logs were returned, so the available data is more limited. However, if these are taken as representative, they are revealing. On average 200 minutes were spent in face-to-face communication, 21 minutes on e-mail communication, 29 minutes on telephone communication (including the sending of faxes), and 242 minutes on independent activity. What is interesting is that the overall time spent on the seminar task was very similar to Group One, but proportionately much less time was spent on e-mail, and more on face-to-face (and fax) communication, consonant with the e-mail frequency data noted previously. Face-to-face communication for Group Two included more working together, on top of the strategic uses made by Group One. As conjectured earlier, then, lack of e-mail contact via the shared conference did not apparently signify lack of engagement with the task (or substantial use of the private mailboxes, for that matter), but rather a use of other methods of working and other channels of communication.

The reason for these differences still remains somewhat unclear at this point. Group Two contained the person who had the greatest difficulty getting online, but these problems were solved by the time the Group Two task was set, and in any case this person was amongst the more frequent Group Two users of e-mail. One factor which might have been significant, given the functions of e-mail for Group One, was that Group Two did report more difficulty sending and receiving attachments, in part because of mismatches between the resident word processing software (Word and ClarisWorks) on the group members' machines.

Finally, the group project logs were again not as informative as might have been hoped. Only two out of the twelve trainees returned these, one before the conferencing system was set up, and one after. Given these numbers, it is hard to tell how representative the data are. However, the responses are in fact consistent with the picture presented above of face-to-face communication being to some extent pared down to strategic discussion after the introduction of *FirstClass*, with e-mail taking on the function of information exchange.

3) Was the experience of using the system perceived to be positive, and what further support would be helpful?

The pattern of interaction, certainly for Group One, was consistent with the conferencing system having been relatively successful. This was no guarantee that the experience of using it was *perceived* to be

positive, however, and in order to sustain future use, it was important to be sure that at least some positive perceptions were present, so that these could be built on later. To ascertain whether this was in fact the case, after each group's face-to-face seminar those who had drafted the seminar paper were asked to complete a brief **questionnaire**. This dealt with respondents' experience of e-mail prior to the course and their initial confidence about carrying out the seminar task; the perceived usability of the conferencing system and software; which aspects of the task had been seen as positive, and which as negative; and which features of the system, if any, had been perceived as facilitating completion of the task.

Looking at Group One and Group Two responses separately in view of other identified differences between them, for Group One five out of six questionnaires were returned. Only one of the five respondents reported having had previous experience with e-mail, suggesting that whatever else was the case, the differences between Group One and Group Two were not attributable to Group One containing more of those who had used e-mail before. Despite their lack of past experience, on balance the group members were moderately confident about the exercise at the outset, although most also said they had had doubts about the software and its reliability, and all respondents stated that more initial instruction in *FirstClass* (especially sending attachments) would have been helpful. All respondents reported having subsequently experienced access problems due to network difficulties or lack of availability of machines, and noted that they considered dealing with these problems as key requirements for the success of such systems. However, there were positive aspects. All the respondents liked the speed of exchange which e-mail allowed, and most also mentioned the convenience of asynchronous exchange (a common finding), which meant not having to wait till someone was in, and having time to think about replies. All felt that learning about conferencing was the most useful aspect of the exercise, and that keeping in touch or discussing were the least useful (cf. the relative lack of use of the conference for this, and the availability of face-to-face contact). At the same time, the most frequently mentioned positive outcome was the successful joint production of the seminar paper, so that the exercise as a whole can be claimed to have been seen as facilitating productive exchange.

For Group Two, again five out of six questionnaires were returned. Two out of the five respondents reported having had previous experience with e-mail (confirming the lack of difference between the groups in background experience), and again on balance the group members had been moderately confident about the exercise at the outset. In general, the pattern of other responses was similar to those given by Group One, except that there was greater emphasis on technical problems, no mention of the benefits of asynchronicity (perhaps reflecting paucity of use of the system), and a less positive reaction to the exercise as a whole. It is not clear from the questionnaires whether it was due to actual technical problems, but the group reportedly decided to split into pairs for the exercise, hence the greater incidence of working together noted in the logs, and the lower use of e-mail.

The implication, then, is that technical difficulties led Group Two to adopt a structure for the seminar task which minimised the need for exchange, and that *this* was the primary reason for the differences in interaction patterns between Group One and Group Two. It is not clear whether these technical difficulties were more perceived or actual. One possibility is that the group had greater lack of confidence in the system because they had fewer early frequent users: three in Group One, against one, or at most two in Group Two. As a result, Group One may have had a "critical mass" of users which was sufficient to persevere and overcome any lack of confidence in the system, whereas Group Two did not. Whatever the cause, though, it seems likely that because of the structure they adopted, there was not the same opportunity for Group Two as there was for Group One to experience a positive outcome in terms of joint writing. There are strong echoes here of previous arguments that the character of the procedures negotiated by groups for tackling a task are critical to the success of online conferencing systems (see e.g. Lewis, 1997).

4) Did the provision of the system have positive outcomes for work?

Given the presence of some negative perceptions of the seminar task, and especially its online components, it is pertinent to ask whether these were justified by the quality of the actual *products* of the task. More generally, in addition to developing practical IT skills, it had originally been hoped that the project would develop the trainees' skills in synthesising and evaluating data through increased discussion either directly using, or facilitated by CMC. In order to address these points, the intention had been to **assess written work** against key criteria, especially the presence of critical reflection (i.e. the exploration and critiquing of issues, rather than simple awareness of their

existence). To date, however, the seminar briefing papers have not been formally assessed, although they were judged by the course tutors to be of a high standard, and will go up on the course web site for wider access by other professionals. Further analysis is needed here. A related issue here is that of the longer-term impact of the conferencing system on the trainees' professional work, and that of those they work with subsequently. It is too early to establish this at present, but the intention is to **monitor usage of the professional conferencing system** after the trainees' graduation in 1999. In particular, the format of the post-graduation induction year laid down by the BPS will provide trainees with the opportunity to organise and extend their own professional development via online resources, including the conferencing system, and activity at this point will be examined with interest.

Conclusions

The project can be argued to have gone some way towards achieving its principal aims, and will be further developed next session. The conferencing system appears to be well on its way to attaining a distinctive function, although this is not in itself discursive in character at this point, and its value may therefore be to some extent task-specific. It has, however, fitted reasonably well into other activities, and the net effect overall has probably been to increase the amount and structure of productive exchange between trainees. Given the more negative experience of Group Two, though, it is likely that further explicit support and tying of conferencing to set tasks will be necessary before use of the system becomes self-sustaining, and the impressions caused by the false start are overcome.

It will also be necessary to ensure greater reliability of connections in future. In this respect, the experience has flagged up a number of practical problems which should be borne in mind by others interested in implementing CMC under similar conditions. There are three key points here. First of all, it is crucial to secure the reliability of the system across all points of use *at the outset* . This may have resource implications, since, for example, the ability to provide a modem or a lap-top computer may be an important means of contributing substantially to reliability. Secondly, there is a need to establish early on the optimum operating parameters of the system, including what format to use for attachments, especially where there are different hardware and software platforms being used within the same network (RTF files were eventually found to be the most portable in the present case). Thirdly, there is a need to provide training and hands-on experience, including training in the more advanced functions, at all locations which will be used (e.g. in the present case, in the practice bases, not just in the university), since what works one way in one location may work differently in another.

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CALculating Success?

Joanne Smailes, University of Northumbria at Newcastle

Abstract

Quantitative subjects form an integral core of the degree programmes offered at Newcastle Business School (NBS). Preparation and delivery of the subject matter assumes that all students have the standard requirement of GCSE Grade C or equivalent in mathematics. Increasingly, however, experience indicates that many students, on entry, exhibit weak numerical aptitude. In an attempt to address this, an additional option unit (elective) has been introduced allowing students the opportunity to update their skills base and develop more confidence in handling numerical problems. Consequently, business modelling staff at NBS have selected this unit to pilot the use of in-house computer aided learning materials as the principal vehicle for the delivery of the syllabus.

This paper evaluates the effectiveness of this software based approach as a teaching method and its subsequent impact on developing expertise. A discussion of how the customisation of the program has created advantageous by-products of administrative data capture and analysis, as well as accountability of students' individual learning needs, is also addressed.

Furthermore, the changing roles of both student and lecturer within a computer aided learning environment are examined, with emphasis placed on the possible formulation of a "best practice" strategy for the future integration of computer aided learning within the mainstream curriculum.

At Newcastle Business School (NBS), as with most others, each student must study quantitative methods as an integral core of their degree programme. Increasingly, however, numerous press reports and lecturers' experiences indicate that many students embarking on a higher education course actually have a weak numerical aptitude. This concern has even been expressed with regard to mathematical degrees, for example in October 1994, Manchester and Southampton Universities introduced four year extended mathematics degree courses in order to cope with the dwindling numerical knowledge base of incoming students.

At NBS a similar decline has been observed and there is no doubt that the majority of students would benefit from numeracy skills revision at the beginning of their course of study. In reality however, there are a number of factors preventing this via the traditional lecture / tutorial route:

- students intakes are high, group sizes of 100+ are not uncommon;
- contact time, particularly during induction, is limited;
- on the part of the students, there appears to be a fear of them admitting that they need help.

At present such revision is only available by choice. The University of Northumbria, of which NBS is a faculty, operates a Centre for Writing and Numeracy Development. Students of any discipline can consult staff and the resources of this centre. NBS students can also elect to study a 12 week unit during the second semester entitled basic quantitative techniques for business. Having a personal interest in numeracy problems within business education, it was inevitable that I would be selected to lead this unit. In its present form, being lecture and seminar based, it can only cater for a relatively small number of students. Nonetheless, I believed that this would be a perfect opportunity to consider the ways in which this provision could be expanded and I believed computer aided learning was a possible solution which could perhaps overcome the stumbling blocks mentioned above. Research from previous studies and evidence collected via the optional unit would provide me with the opportunity to prove this.

This paper intends to firstly justify the choice of Computer Aided Learning as well as defining exactly what constitutes business numeracy in NBS. This will be followed by an appraisal of the use of such materials on the basic quantitative techniques for business unit. Finally, in connection to this, general issues relating to the future, which arose during this evaluation will be discussed.

Why Computer Aided Learning ?

The use of computer aided learning (CAL) in science and mathematics is by no means a new idea. One of the first reported instances was the Programmed Logic for Automatic Teaching Operation (PLATO) in 1960 at the University of Illinois. It is important to note, that prior to this, was a facility called 'Skinner's box', a linear teaching machine which perhaps could be regarded as a form of automated instruction. Studies into the use of CAL for mathematics teaching are somewhat limited and in the main tend to be associated with children of school age. Not until the late 1980's and early 1990's did CAL within further and higher education emerge as a prominent field of study.

In Multi Media Computer Assisted Learning (edited by P. Barker), Yeow-Chin Yong (1989) from Ngee Ann Polytechnic directly discusses the considerable value of CAL in the teaching of mathematics and science. This study recognises that to make the most of student teacher interaction, in these areas, class sizes should be ideally around ten but that in reality within higher education class sizes are much larger (as is the case in NBS). Yong offers CAL as a practical solution to support teachers who deal with classes of this size, hence complying with the first of three stumbling blocks. As CAL is a physical rather than a personnel resource, contact between staff and students can be greatly reduced satisfying the second of the three factors mentioned in the introduction. To overcome the third and final factor once again, in terms of resourcing, physical versus personnel plays a major role. Vinegrad (1987) emphasises that CAL can easily provide "a learning by example paradigm" which is especially relevant to areas such as numeracy where expertise is based on the "acquisition of procedural knowledge". Yong states that CAL is an ideal vehicle to consolidate, revise and self assess especially in areas, such as numeracy, where students can develop an inferiority complex. Hence, these studies suggest that CAL indeed helps conquer an inherent fear of an academic specialist.

Whilst conducting the research for this paper, the definition of numeracy typically varied from one study to another. Therefore in the following section as a term of reference for this study its meaning is clarified.

What exactly constitutes basic numeracy in business education ?

On entry to the university, students (excluding mature and overseas) must have at least a grade C or equivalent in GCSE mathematics. Obviously, as business studies students they are not expected to be highly proficient mathematicians and to be competent in all subjects covered by the GCSE syllabus. However, there are certain areas which are assumed in the preparation and delivery of the core NBS business modelling programme. These are:

- addition, subtraction, multiplication, division and their order of manipulation;
- standard form / scientific notation;
- directed numbers;
- fractions;
- percentages and ratio;
- simple algebra.

The aim of the basic quantitative techniques for business unit is to establish the basic numeracy skills which are assumed within the core business modelling units whilst developing confidence in handling numerical data. Accordingly the subjects listed above are defined as "business numeracy" and form the outline syllabus for the unit.

Software "fit for purpose"

Initially, rather than trying to "reinvent the wheel" I looked round for existing CAL materials covering the defined areas of business numeracy which could be adopted for use. As a first port of call, the Teaching and Learning Technology Projects (TLTP) were considered. Two of these projects one of which is led by the Imperial College London and the University of Leeds, the other led by the University of Newcastle, are concerned with remedial mathematics. Over the last couple of years I have attended conferences were both of these projects were demonstrated. In both cases, the software is of the highest calibre, yet in my opinion more geared towards engineering and science. Secondly, I referred to an Internet web page set up by Sheffield Hallam University. This web site (last updated in October 1997) fortuitously reviews all available mathematical software to date. By consulting these extensive reviews again none were deemed suitable in this instance.

Besides, Yong asserted that it is imperative that teachers develop their own in-house materials in order for general enthusiasm, optimism and momentum to be gathered so as to cultivate CAL

within an organisation. I strongly subscribe to this view and consequently created a business numeracy package using 'Asymetrix Multimedia Toolbook' which was an authoring tool. This package (present working title of which is CRUNCH) consists of a diagnostic check, revision modules, informative assessments plus an associated management information system.

In 1998 these in-house computer aided learning materials were complete enough to pilot on the basic quantitative techniques for business option unit. The general focus of this pilot was to assess whether numeracy standards were improved by this CAL medium, and to examine whether information gathered by the management information system is beneficial for administration purposes. Additionally, I was particularly interested in pursuing the following questions:

- How do students look upon CAL as a teaching medium?
- How would colleagues perceive the use of such materials?

I would also have liked to confirm whether or not students have problems admitting that their numerical ability is weak. However, because the pilot group are there through self selection, does this not suggest that this problem can not be adequately addressed without bias? It is this concern, that at present, unfortunately, can only be flagged for future investigation.

General evaluation

A variety of data collection methods were employed including questionnaires, semi-structured interviews and observation.

The pilot group was composed of nineteen students from an assortment of first and second year courses within NBS. Nine of these students were categorised as being mature and three overseas (of these two were also mature) hence giving a diversity of backgrounds. It should be noted that all of the participants have studied at least one of the core quantitative methods courses in NBS.

In the first session of the course the students undertook a diagnostic assessment. This consisted of twenty questions each designed to relate directly to elements of the mathematical skills covered by the syllabus. The management information system was structured to collect some basic background information (e.g. age, GCSE grade) along with data pertaining to question responses entered. Once students completed the questions to their own satisfaction, they simply clicked a button which automatically marked their assessment, then offered some general feedback and issued them with their own unique study plan. This study plan simply consisted of a list of the modules they were expected to work through in the succeeding sessions. In the aim of increasing self-confidence in number handling calculator use throughout the course was restricted. As an additional aside: mental arithmetic is a useful skill particularly as psychometric testing of numerical skills is increasingly used by employers in recruitment and selection; a number of these tests do not allow the use of a calculator. (Example: Graduate Managerial Assessment (GMA) - Numerical).

As this assessment was purely a diagnostic check, numerical results were not formally collected but student feedback was accumulated via questionnaire. On the whole, 69% of the students considered that their performance on the assessment was as expected, 18% thought that they had done better than expected.

When reflecting on their general opinion of the assessment's difficulty, 63% believed it to be achievable while the remainder found it to be a challenge. This provides reassurances that the diagnostic and informative assessments have been pitched at an appropriate level.

Data collected by the management information system did permit an analysis of group performance. Interestingly, some particular areas of weakness emerged, these being the questions on the order of operator manipulation, multiplication and division of fractions and algebra. This information proved very useful in preparing extra support material.

In subsequent sessions, I became a bit of a spare part. I just wandered round whilst the group studiously worked through modules listed on their individual learning plans. Many informal comments were made during these sessions all of which were very positive and attendance levels were good. The students, who knew this was the first time CAL had been used, were very keen to contribute and reported any glitches and, on their own initiative, made useful suggestions on how the materials could be adapted.

The group was asked to estimate how much time had been spent on the individual modules and on average this was estimated as being between 20 and 25 minutes. In the case of fractions, one of the highlighted areas of weakness, generally a little

more time was required, an average of 30 minutes. Encouragingly, around a quarter of the students invested significant amounts of time on the modules outside of the formal sessions. The commitment of the students and the employment of this software based approach, resulted in the syllabus being completed in two thirds of the overall allotted timetable provision. At this point, students were given an informative assessment its format being identical to that of the diagnostic check. On this assessment, all substantially improved their performance and it is predicted that all will perform well in the terminal examination in June. However, once again the management information system indicated algebra as a continuing problem (the other two now being virtually eliminated). Consequently, the final third of the unit will be used to concentrate on this area in more detail, albeit by traditional means. On the whole, the evidence gathered from this pilot along with previous studies has provided sufficient corroboration that computer aided learning materials can improve numeracy skills whilst reducing the need for staff student contact.

The paper will now move on to contemplate the questions posed earlier on student and lecturer perceptions of a CAL environment.

The student and the CAL environment

Specific reference to student reaction to CAL for basic numeracy is made by Clare (1991). He provides an honest objective view in the use of in-house materials at the Matthew Boulton College of Further Education (project started in 1986) with varying student intakes. Overall, the reaction to and the success of the materials was fairly mixed "...student reaction is not as positive as we have experienced before...". Nevertheless, it was noted that, in the case of algebra, even though students' resistance had not be eliminated teachers did express it had been reduced and in their experience students were happier than previous classes had been. In contrast Tan, Yong and Tan (1987) carried out a survey where feedback from both staff and students to CAL materials was very positive, particularly with regard to an eagerness to attend sessions. My experiences have been more in line with those of Tan, Yong and Tan.

As mentioned earlier, most of the time I felt that my presence was surplus to requirements. So, via questionnaire, followed up by interviews, students were asked whether they felt it was necessary to have a subject specialist in attendance. Opinions on this were split pretty much fifty-fifty. The proposition was introduced that if the numeracy sessions were unstaffed, would they still have turned up, seventy-five percent replied yes. Consequently this was contradicted, with around 60% of the group stating CAL sessions should be formally timetabled with a lecturer present. At interview, this was expanded upon by a couple of students who asserted staff presence was recommended for discipline. To illustrate, they quoted an instance where a workbook had been issued on another unit. Admissions surfaced that a great deal of the work had not been started, let alone completed, even though it was understood that assessments were to take place at the end of the semester.

Moving on to points related to independent learning, the question "If CAL was available as an optional extra to the main course of study would you make use of it?" was posed. An overwhelming majority honestly declared that they would only do so at revision time with the rest saying that they would perhaps use it occasionally to back up their study. Assuringly however, no one stated that they would not bother with CAL, but again a desire for a little more enforced discipline was expressed.

Following on, the idea of CAL materials, for instance, replacing lectures was debated. Even though general opinion affirmed that the CAL materials were excellent and had without any doubt improved their understanding, the preference was for lectures with the addition of staffed CAL sessions. Justification being that at times there were still certain things requiring clarification; in those situations a lecturer was essential for consultation.

"Computers cannot anticipate exactly what you don't understand."

During interviews, it was stressed that these staff reliant attitudes were mainly based on their feelings towards the new environment of university life, particularly the social aspects.

"It can be quite a culture shock"

So, in terms of academic learning they simply desired more direction, for example registers to encourage attendance.

The lecturer and the CAL environment.

Past studies have revealed that, from a lecturer's perspective, a common fear associated with using CAL is its potential threat to their jobs. For instance Clare assures us that the CAL materials at Matthew Boulton College, were not complete courses, and that skills such as problem solving were not included, therefore it would not be envisaged that teachers would be replaced by such materials. Yong also stressed that CAL should be

used to "support not threaten" teachers. Obviously, as I have a personal interest in the development of CAL, my views could be seen as optimistic and biased.

In order to gain a more objective view from my colleagues, a staff seminar reporting the findings above, followed by an open discussion, was held to assimilate views on CAL's role in quantitative subjects. The outcomes were incredibly heartening. Over the last couple of years lecture sizes have in most cases tripled and now a typical lecture is presented to 200+ students. Smaller group sizes (approximately 25) are only encountered during workshop sessions where emphasis is placed on spreadsheet use. Against this backdrop, all members, including myself, assigned to the view, that CAL is a very important support tool of the future. Student views regarding the timetabling of CAL sessions were passed on and even though there was great empathy, all lecturers recognise that an independent learning culture within universities is now common place. Staff agreed that students require guidance to ease them into this culture at induction (programmes of this nature are being developed) but as subject specialists we should concentrate on strategies for using CAL, not only as an additional student resource but also as a lecturer support tool. Subsequent dialogue revolved around how the numeracy materials can be incorporated into the mainstream curriculum, plus a confident expectation of additional materials to be developed. Many decisions were made which I will be introducing in the conclusion.

Conclusions and future developments

The cultivation of the CRUNCH materials referred to in this paper has been a long process. Primarily, this was due to myself being the sole developer along with a number of technical issues encountered with network compatibility. During 1997 however, NBS kindly funded a placement student dedicated to this project, the result of which instigated a speedier completion. The pilot group was small and by nature of self selection, one important factor relating to numeracy (i.e. student fear of admission) has had to be excluded from this research. There were a sufficient number however, to be representative of general issues and root out any technical errors. The students have expressed gratitude to the use of CAL and all have reported significant benefits in terms of both ability and confidence. From the student perspective, there was a little reluctance towards CAL as an independent learning resource, but I believe that with efficient coaching in "learning to learn" this will be overcome. The expectation of staff resistance to CAL was unfounded and comments were exclusively directed towards expansion. As these have radical implications for the near future they will now be elaborated upon. To start with, word on the success of the pilot had been passed on to higher management. They have advocated a larger trial in September 1998, on the BA Business Administration course. The intention is to timetable the diagnostic checks into the induction program and introduce the CRUNCH materials as an independent study resource.

As a "carrot", students are informed that three or four weeks into the main quantitative course a follow up assessment will be issued (the decision is yet to be established as to whether this will be formative or informative). A full implementation is being planned for the following year.

One of the considerable dilemmas recently encountered, has been the provision of both informative and formative assessment, other than by a terminal examination, for large student numbers. As the management information system and assessments have proven successful and easily adaptable for data capture, it was agreed that a secondary system of computerised assessments should be adopted in the mainstream quantitative subject areas. Ergo, equipping both staff and students with scope to review performance at regular intervals. Again this will be piloted during the next academic year.

Finally, the Dearing Report on Higher Education identified four "*key skills*" of which numeracy is one. In 1997 the University of Northumbria's Academic Board approved the implementation, across all courses, of a Key Skill Model over a period of three years. Subsequently a representative panel, across all university facilities was constructed to consider ways in which this can be achieved. An advisor to this panel attended the staff seminar whereupon it was suggested that these materials may be put forward as a possible delivery method for the numeracy key skill.

In its entirety results have been extraordinarily favourable, and personally I am thrilled that CAL has been highlighted as an issue for wide ranging expansion, with future possibilities for research. To sum up then, (pun intended) I envisage a CALculated success!

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Development and Evaluation of WWW Resources to Support Research Methods and Electronic Engineering: a comparison

Robert Newton, Iain Middleton, Rita Marcella, Alan MacLennan The Robert Gordon University

Abstract

This paper describes the development and evaluation of two WWW based resources developed under a single funding programme during 1997 at The Robert Gordon University: 1) ReMOTE: a resource of collected materials for teaching and learning Research Methods skills; 2) Personal and Mobile Communications: a module of a postgraduate course offered by the School of Electronic and Electrical Engineering. The projects differed in their rationales for development, subject matter, manner of development and in the evaluation of their final deliverables. These issues are compared and contrasted and their effects on the outcome of their final evaluations highlighted. Problems associated with the effective evaluation of each arose for a variety of foreseeable and unexpected reasons: for example the difficulty in getting access to students in order to conduct evaluations, practical problems preventing the participation of lecturing staff, low levels of responses to surveys and in one case the presence of only a single student electing to take a course. Finally, the positive and negative elements of each experience are used to draw up a series of recommendations for future developments. These include: the need to design for a clear purpose; the need for close co-operation and input from relevant teaching staff; and a requirement for advance planning of the timetabling and logistical requirements of evaluation planning.

Introduction

In January 1997 the ReMOTE (*Research Methods Online Teaching Environment*) project received funding for a 12 month period via the Violet Lessel Trust Fund - an internal fund to support teaching and learning initiatives within the Robert Gordon University. The original purpose of the project was to develop a World Wide Web (WWW) site devoted to the support materials for teaching Research Methods and to integrate access to a range of in-house material with Internet based teaching materials . The project team had previously had experience of creating web sites to facilitate access to teaching and learning materials using a variety of techniques - multimedia authoring packages to develop in-house teaching materials to support a taught unit in bibliographic classification, creating a web based information skills tutorial to support open and distance learners within a public library and developing and maintaining an online directory of teaching and learning resources related to Internet skills training (NetLEARN).

During the initial discussions within the University relating to the project's remit it was decided to extend the project to include development of tailored web based materials in a specific subject discipline (Electronic and Electrical Engineering).

The project thus comprised two distinct parts associated with two schools within the University.

1) **School of Information and Media**: the ReMOTE (*Research Methods Online Teaching Environment*) project's purpose was to develop a World Wide Web site devoted to the teaching of Research Methods, unifying access to materials on the topic developed in-house (primarily from an existing print based *Self Study Learning Package for Research Methods).* The remit covered:

- the identification and conversion of existing RGU materials to WWW format;
- collection and classification of relevant WWW links;
- the development of interface for integration of these resources within taught programmes - specifically at students on the postgraduate Information Analysis course.

2) **School of Electronic and Electrical Engineering**: production of two postgraduate level modules to complement the teaching of these subjects in the school, giving overviews of their respective areas. The remit covered the production, conversion, acquisition and obtaining clearance for use of materials.

The funding was allocated to provide a full time research assistant to develop the materials. The Research Methods element received the bulk of the funding, and accordingly was allocated the bulk of the developer's time: nominally 4 days/week to the

remainder's 1 day/week. The role of the developer was to liase with the staff at whom the resources were primarily aimed and to undertake development according to their needs. This paper will be presented in two parts and provide a discussion of both projects but will concentrate primarily on issues arising out of the ReMOTE project.

ReMOTE - Background and Rationale

Virtually all UK higher education institutions teach Research Methods both in undergraduate and postgraduate programmes. In the latter Research Methods is often seen as a key component in preparing students to undertake study leading to an MA or MSc qualification. Typically the topic is taught as a programme of lectures and seminars.

The key features of Research Methods which make it an appropriate area to develop as an Internet resource are that:

- it is generic and transferable;
- because of the wide range of potential topics which could be matched to an individual student's dissertation it is often the case that each student requires a different level of depth for different topics (this is particularly true for postgraduate programmes of study);
- the environment in which the project will be operating (the WWW) is one which is increasingly important in conducting practical research. It was thus felt that exposing students to learning using the Internet as a mechanism for delivery might in fact contribute to the learning process.

It is therefore apparent that such a widely applicable skill as Research Methods, and such a ubiquitous medium of delivery as the WWW are potentially suited for the development of a resource centre which might be of global utility.

Currently there are several WWW resources available for teaching Research Methods or facilitating the research process, the former typically concentrate on a subset of skills appropriate to a particular discipline or a single aspect of Research Methods, while the latter (e.g. SOSIG) tend to offer sites of use to researchers, and a few selected sites for teaching the subject. Pachnowski et al. provide a useful discussion of some of the sites available which provide databases and examples of surveys of resources (e.g. the US Census Bureau http://www.census.gov) and the Gallup Organization (http: //www.gallup.com) but do not provide any detailed guidance on application of these resources in teaching. Useful resources are also identified by a range of directories - the Educator's Internet Yellow Pages being a particularly good starting point. More specifically related to Research Methods work by Cozby provides an excellent guide to resources - each chapter of the book directing the student to a wide range of web resources. There are also a number of web sites which give detailed tutorials on specific Research Methods concerns or techniques (e.g. BeLue's Choosing a research design http://trochim.human.cornell.edu/tutorial/belue/belue.htm and Burn's pages on Securing internal validity http://trochim.human.cornell.edu/tutorial/burns/int.html).

Aim

The aim of ReMOTE was to provide an infrastructure which allows direct links to specialist sources which will enable the use of existing WWW materials as "plug-in teaching nodes" when developing tailored Research Methods courses. The project aimed to integrate the use of internal electronic based materials with those available on the web. For a particular taught course, therefore, academic staff could provide programmes of study which made extensive use of links to electronic 'readings' in the same way as references to the sources would normally be given in paper based documents. The researchers then tested the effectiveness of the approach and the problems which this particular type of development raised and studied the manner in which the ReMOTE pages were used by staff and students within the University.

Design and Structure

The structural and graphical design of the site required careful consideration in order to achieve a consistent and logical appearance. The factors which required to be taken into consideration included the goals of the potential users and of the university itself:

Usability Goals:

Navigability: use of logical structures to maximise the ease of use with which a user can locate the information they require, and to prevent them becoming "lost" in a complex structure of information.

Clarity: the need for all of the possibilities to be presented in a clear and comprehensible manner, making it clear at each stage - without the need for undue searching or experimentation on the user's

part - exactly what information can be reached from the current point.
Attention to design: with all of the alternative sources of information on the WWW, it must be made obvious to the user that the resource has not been developed as a part-time "pet project" by an individual. A professionally designed look will be appealing on a visual level and engender confidence that this is a quality resource.

Institutional Goals:

The need to establish ownership and a corporate identity; to remind users that the Robert Gordon University is providing this resource.
To provide a robust structure for the resource which will accommodate future changes and additions to the site in a logical manner without the need for excessive re-working of existing structures.
To provide quality information in a manner which: enhances the pedagogical aims of the university; and enhances the profile of the university as an innovator in the use of novel techniques for information delivery.

On a practical level, these issues fall into two broad categories: Graphic design & Structural design.

Graphic Design

Graphic Design: Identity
It was decided that the three essential elements were:

- The pedagogical purpose of the site: i.e. the teaching of Research Methods skills;
- The use of technology (the WWW) to enable distance or independent learning;
- Institutional ownership of the resource.

The site's opening page is shown in Fig.1.

The banner graphic uses considerable corporate and research-appropriate imagery. The underlying graphic consists of photographs taken from the 1998 prospectus which illustrate elements of research; themes represented include use of telephones, interpersonal skills, technology (computer keyboard, CD-ROMs, floppy disks), libraries, study, books, files etc. The RGU shield and corporate colours are also prominent.

The title *ReMOTE* itself is an acronym constructed from the words "Research Methods Online Teaching Environment". The use of the term "remote" also reinforces the distance learning aspect.

The site content is overlaid on a background consisting of the undulating margin adopted on RGU publications, with the individual elements of the RGU shield (castle, boar's head, cog, sphere and torch) continuing to the right hand side. The undulating margin serves a functional purpose, containing the navigation "buttons" which enable the user to access the site.
These graphic themes run throughout the contents of the site, and provide a consistent look and feel: it is easy for a user to tell which pages are part of the ReMOTE site.

Graphic Design: Functionality
In addition to fostering a strong sense of purpose, technology and ownership ("PTO" identity), many of the graphics have a functional purpose. A decision was made that the non-use of graphics should, wherever possible, not inhibit use of the site: non-graphical browsers are still in use and browsing on standard browsers may be speeded by switching off graphics. Therefore functional graphics in the site are of a simple nature, generally only renditions of text with some embellishment e.g.
Navigation: the navigation buttons in the left hand margin, where the current page is highlighted in green with a tick beside it to make it absolutely clear to the user where they currently are in the structure. The functionality will be only marginally less clear if browsing in text only.
Pedagogy: in the actual learning materials, graphics do have an essential purpose. Where they are necessary, they have been kept to the minimum size for legibility on displays of varying resolution. However, the issues which can be discussed here are purely technical, since the use and design of these graphics are issues for the materials' authors.

Structural Design

The site is built on a hierarchical plan, where the most general resources contain links to the more specific ones. The home page serves to inform users of the purpose of the site and give access to the broad categories (not to the actual materials).

The pages on the next level down provide access to
i) a directory of Research Methods teaching resources available on the WWW arranged in broad subject categories,
ii) online resources produced by staff in the University and held on the university server,
iii) online course descriptions which integrate access to online resources students registered on specific courses.

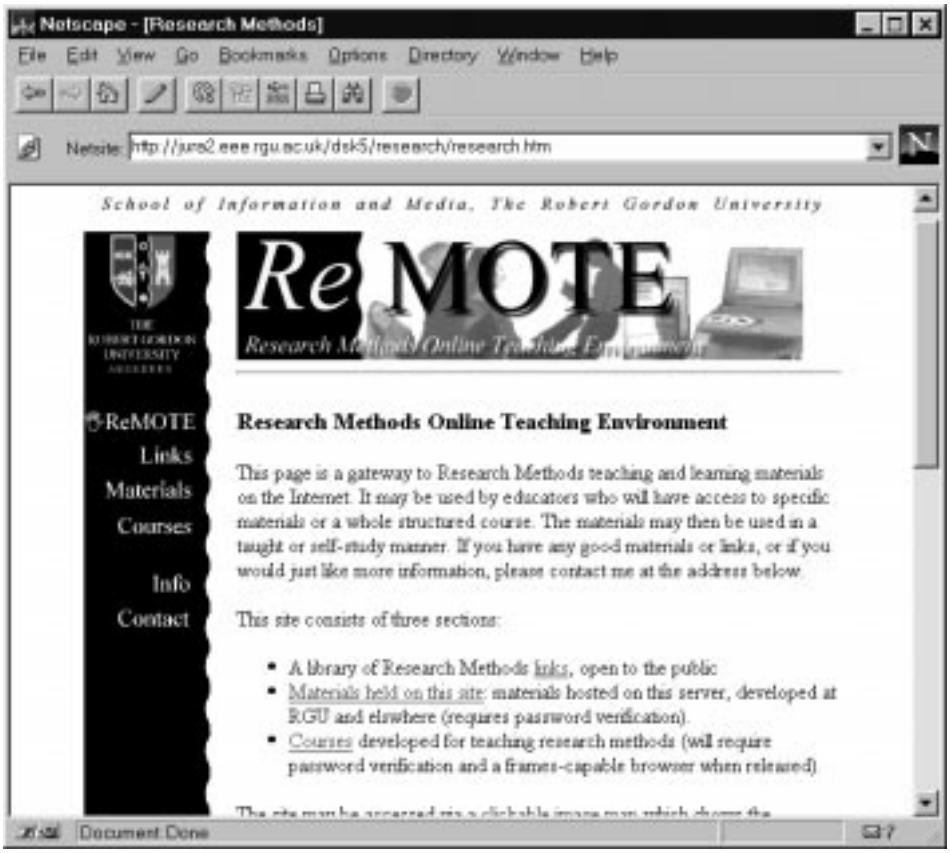

Figure 1: The ReMOTE Opening Sreen.

Pages on the top two levels of the hierarchy link clearly to each other, so that a user does not have to backtrack to the home page every time a different section is required. The materials which have been installed on the server are structured in a manner reflecting as far as is possible that of the original materials. There have been some necessary alterations in terms of navigation e.g. the addition of hypertext contents pages.

Content of ReMOTE:

The contents will be dealt with in three parts:

- The directory of links to other WWW materials;
- The materials actually hosted on the server;
- Courses under development using the above materials.

Directory of Links

Requests for WWW Links

This was a significant part of the final deliverable of the project - it is a collection of links to already-existing materials elsewhere on the WWW. In order to identify materials for evaluation and possible inclusion in the site, input was solicited from a variety of e-mail discussion lists and online forums which have an interest in web site development and teaching Research Methods. An announcement of the project's intentions, coupled with a request for contributions, was sent out to:

- Mailbase UK Higher Education's electronic discussions host. A number of lists were identified which might have an interest in the development of such a resource, including:
- lis-link@mailbase.ac.uk
- lis-infoskills@mailbase.ac.uk,
- computer-assisted-learning@mailbase.ac.uk
- Other e-mail lists and electronic forums, including:
  Nettrain@listserv.acsu.buffalo.edu

A number of responses to this message were received, generally of a positive nature, although most revolved around the theme of "please let me know when it's ready". However, several worthwhile resources on the WWW were communicated, and

Figure 2: Categories in the directory of WWW links

some sites and individuals promised to donate materials, or to look into the practicalities of doing so. Similar messages were sent to individual sources which it was known had produced materials which might be suited to WWW conversion e.g. the PROCARE project at Southampton University. As in the case of the individuals who responded to the initial request offering their own materials for the site, enthusiastic initial responses have been followed by long periods of silence: in the case of PROCARE, copyright clearance deliberations at board level have thus far prevented any progress.

Searching on the WWW

In addition to asking interest groups to provide references, further materials - finally forming the bulk of the directory - were located using WWW searching techniques. Many materials were located via previously located WWW sites, which often include a list of links to other related sites ("further reading"). This has the advantage of the implicit recommendation by the link-maker in referring to the materials, but also restricts the user to what the individual author has himself already found.

Searching was therefore extended to Internet directories and search engines e.g. Yahoo, The Argus Clearinghouse, AltaVista, Excite, Infoseek. This is a less focused method of identifying suitable resources than by individual recommendations, but has the potential to identify a much wider range of resources, and the majority of the directory's contents have been located by this method.

Directory entries

Due to the extensive nature of the directory of links, it has been subdivided into categories for each aspect of Research Methods. Each category of the directory has a separate page, accessed from the main directory page. The format for directory entries is based on the style used in the *NetLearn* project. The resource title is given as a hypertext link, followed by a brief abstract describing the resource, its coverage, target group etc and finally some categorisation information. The information given should be enough to tell the user whether the resource is likely to contain the type of information which they might find useful *(fig 3)*.There are a number of drawbacks to the directory in its current form:

- It is not searchable as a database would be. The name, URL, Description and categorisation information could all be used as fields in a database, but at present this is not possible.
- Resources may fit into more than one category, resulting in duplication.
- Updating the directory must be done manually by editing the relevant HTML document: with the amount of information requiring updating: this is unwieldy and prone to errors.

If the directory is to be maintained and promoted as a feature in the future, some investigation must be made into the possibility of converting the information into a database format accessible through a WWW front-end. This would not only make the user's job searching for relevant materials easier, but also the maintainer's job of adding, amending or deleting resources. Scope would then also exist for the addition of a "user comment" feature, where users could add their own annotations as to the usefulness of any individual resource.

STEPS Project, University of Glasgow. Downloadable CAL modules for the teaching and learning of statistics, specifically applied to the following areas: Biology, Business, Geography, Psychology. Suitable for PCs, also some MAC material. The packages utilise graphic and interactive techniques. *TYPE: materials, downloadable CAL software*

Fig 3: an example directory entry

Materials hosted on the server

The basis for the in-house material was the **Research Methods Self Study Learning Package**, a unit designed for students studying Research Methods in the social sciences and produced by the Robert Gordon University School of Public Administration and Law. This consisted of ten papers, each covering a discrete aspect of the subject.

The material was currently being used in printed format, but also existed in electronic format and would not therefore require laborious verbatim retyping. The package consisted of over 100 pages of mixed text and illustrations. The approach taken was to use a conversion utility (MicroSoft Internet Assistant, or IA) which would take existing Word documents as input, converting them into HTML. The process of conversion with IA took only a few hours, but immediately presented problems: each individual Word document was converted into a single HTML document, which was not navigable and required to be broken into sections which would then have to be linked together. The HTML output by IA was also non-standard, and attempted a very literal interpretation of the *look* of the document when what was required was a representation of its structure and meaning. The design parameters of paper and the WWW are not compatible, and the document has required considerable restructuring to make it manageable, and the inclusion of navigational facilities for locating and moving between documents - most notably tables of contents constructed of hypertext links to all of the available pages.

A great number of further problems remained to be rectified due to the shortcomings of IA: many graphics had been discarded, others required re-sizing to make them legible on differing display resolutions and complex text formatting needed to be reinstated. An initial version was presentable after a week of work, but finding and correcting errors produced by IA required much longer, and the assistance of the original authors who were much more familiar with their material. The existence of a template into which content could be "poured" and links added automatically would have saved many days of effort: a single change in style often requires every page to be altered slightly.

The final product retains the original material's content but is structured differently. The materials are broken down into smaller sections and direct access given to each through tables of contents (a device not used in the original materials). Although changes to the material were not within the scope of the project, in the future it is envisaged that they will gradually be altered to suit their new medium more closely, for example by the inclusion of links to outside WWW materials which might be referenced in the same way as texts would be in a conventional paper. An interesting point to note here, however, is that the formative evaluation of CAL materials derived from paper based materials poses considerably more problems than developments geared specifically at the production of electronic deliverables. In part this was reflected in the project in what appeared to be a 'responsibility gap' where the division of responsibility for ensuring accurate transfer from paper to web was not clearly defined. This is also - and potentially more seriously - reflected in what may be termed a 'mind-set gap' which is evidenced by the originators attitude to the value of converting the materials from paper and unwillingness to

grapple with the issues of converting material to a new medium.

Further materials developed elsewhere within the University were also to be considered for inclusion on the server where permission and copyright clearance could be obtained. It was already known that some materials developed in other Schools existed in electronic format and might be suited to conversion to HTML format and included in the 'library of resources' for ReMOTE. The amount of material, developed in isolation by lecturers can only be speculated at. Some individuals have responded enthusiastically to the possibility of making their own notes and lectures available on the WWW - although at the time of writing (more than a year after the start of the project) none have actually delivered any materials. This is clearly an area in which further work is required. We need to develop an institutional policy which will encourage a more collaborative approach to learning materials development and dissemination across the University and investigate fully the factors which are preventing collaborative approaches to developing and sharing teaching materials.

Course Outlines

The final element of the site is the integration of materials into course modules or parts of course modules for specific subject disciplines. It was envisaged that as part of a taught programme materials from ReMOTE could be built into the course - the actual materials and the time suggested for their delivery being determined by the lecturer responsible for the taught unit. These could also be integrated with the lecturer's own materials and used either as a replacement for or extension to normal modes of tuition: it may be prescribed as an activity or coursework, or it may simply be used for "extended references".

The use of the HTML *frames* facility is fundamental to this section. In using this, a lefthand column on the screen is used purely as an index for the actual materials. These materials are called up on the main portion of the screen when an item from the index is chosen. Therefore, if the majority of material to be used consists of existing WWW pages, there is a minimal requirement for writing HTML - this will consist of nothing more than a plain list of URLs.

Taking the Postgraduate Diploma in Information Analysis (PGIA) as an exemplar of how this facility would work in practice the developer used the standard course information which was into HTML format - this included the course unit descriptor and bibliography, plus references to the Social Sciences package and selected lecture notes/OHPs. Ideally it was envisaged that suitable additional areas for online study will be identified in co-operation with the lecturers responsible for teaching the Research Methods module and an online programme of directed study would be created - clearly linking the learning outcomes from the unit descriptor with the aims and objectives of the online learning resources. Even in cases where the learning materials were not web based it was envisaged that such an online programme would have considerable benefit in integrating and structuring material to provide a rich learning environment for students. In practice this was only achieved to a limited extent (because of problems in gaining access to staff and the limited commitment shown by staff to the project) but the project team see this as an important feature of the interface and when the materials are used by future cohorts this feature will be considerably enhanced.

Evaluation

Formal evaluation procedures were carried out for the deliverables which were used in a teaching context during the project. Evaluation proved to extremely difficult partly because of technological problems which arose during the course of evaluating the teaching in class and sequencing the delivery of the online materials. In addition there were problems in motivating the students to participate fully in using the resources provided and accurately interpreting the basis on which students were assessing the materials provided as opposed to the mode of delivery. Too few students participated to allow for statistical manipulation of results and the analysis of findings are essentially qualitative and will have to be confirmed in subsequent studies using larger student populations. Evaluation took place using 4 different user groups providing a range of different situations in which it was envisaged the materials could be used:

1. Tutorial sessions in the computer laboratory with students registered on the Postgraduate Information Analysis course, with immediate user feedback via questionnaire and interview. (A class of 33 students of whom 13 provided formal feedback).
2. Tutorial session as a part of "Using the Internet for Research" course for PhD candidates with immediate user feedback via questionnaire and interview. (A class of 13 research students of whom 7 provided formal feedback).

3. Self-study: - students from another postgraduate course within the School of Information and Media (Electronic Information Management) who used the materials in their own time after an introductory session and who were invited to respond using an online questionnaire. A class of 10 students of whom none provided formal feedback.

External use of the site with online feedback from WWW response forms. Usage statistics are provided below.

Evaluation in tutorial sessions

The ReMOTE web site was first tested during tutorials with students on the Postgraduate Diploma/MSc course in Information Analysis. One week prior to this the class had been given an initial introduction to the site. The class of 30 students was then was divided into three and each division allocated a one-hour timeslot to work through eight questions designed to take them on a "tour" of some of the more important aspects of the site. The hour was designed to acquaint students with the site, encourage them to explore it and to elicit feedback. The feedback was derived by a single questionnaire which consisted of 2 sections:

- section 1 presented students with a set of 8 questions designed to confirm that the student had understood how to navigate the site to obtain specific information;
- section 2 consisted of a series of questions to provide feedback on how the students reacted to the manner in which the course was presented.

Conditions for testing were not ideal, since to fit in with the existing schedule it was necessary to hold the tutorials early in the academic session, prior to the students' introduction to the Internet and before many of them had had the opportunity to familiarise themselves with basic computing. To compensate for this, an introductory session was held in class the previous week where the site was demonstrated, and a handout given with details of how to access the site. However, problems were further compounded on the day of the tutorials by a faulty computer network which made access to the site, for one group (the second group) in particular, almost impossibly slow. These problems persisted for the remainder of the week in question and thus prevented the completion of the exercise by these students out of class, and also prevented their receipt of e-mail requests to complete the exercise.

In spite of the difficulties, each group was able to get some experience of the site, and questionnaire returns show that the majority were able to answer most of the questions posed. Respondents had varying amounts of time in which to complete the exercise: the second group of the three in particular, which experienced such poor network performance that some had less than 20 minutes of the allocated hour after eventually logging in, whereas some students in other groups chose to continue working with the resource throughout two scheduled classes and received supervised assistance for almost 2 hours.

Analysis

The 8 questions which constituted section one were assessed on the basis that an answer was deemed to be correct if it demonstrated that the respondent could locate the relevant information, whatever their subsequent interpretation of it. It was not a test of their Research Methods knowledge, rather the efficacy in identification of appropriate materials. Since it was to be used on what was likely to be the students' first contact with the site, probably even with the Internet itself, the questions were set at a level which reflected the fact that the students were novices.

In all, 14 responses were received to the request to tackle the first 8 questions. Of these, the majority (9) had succeeded in answering all 8 questions and no student achieved a score of less than 5.

Individual performances along with formal and informal feedback showed that respondents' experiences had varied widely: while some managed to complete the exercise with little assistance (and working under the poor conditions noted above), others required more time and/or help. Some language difficulties occurred, as did problems resulting from a lack of familiarity with the technology. It is interesting to note that the group which experienced by far the most severe technical problems, having the least time to complete the exercise, were in fact observed to proceed more confidently and successfully than the final group who experienced few if any technical problems, but as a group proceeded with considerable caution and lack of self-assurance, often becoming "stuck" at the same points, with and without explicit visual and verbal cues. There is no evidence, nor indeed likelihood of any major difference in skill level between these groups: it is thought that among those who are almost uniformly inexperienced in the technology and subject in hand, the *atmosphere* of the tutorial was a significant factor in their progress

through the materials: good humour developed among the group which experienced the most technical problems, and they realised that they had little time in which to achieve a great deal. The next group did not "gel" in this fashion, and required considerable reassurance and assistance. The importance of the role of the tutor in such situations is noted, and this is not restricted to supporting students in understanding technical issues and helping them overcome problems in using the interface, but extends into the role of a "counsellor" who can provide motivation and enthuse students.

The section two 'feedback' questions were designed to provide a gauge of initial response to the resource, and were therefore brief and couched in general terms. The feedback questions were included as a continuation of the questions designed to test ability to use the site, in order to convey the idea that the feedback was an integral part of the exercise i.e. not an optional extra. It required little effort to complete: responses were given on a 4 point Likert scale, chosen to avoid the temptation of respondents to choose a "middle" answer each time. In spite of this, the preponderance of 3's suggests that inexperience prevented a highly informed critical appraisal, and what we can infer is an open minded but often unsure attitude to the site's usefulness.

In all 13 students provided feedback information via the questionnaire.

The first two questions were purely to elicit information about the individual using the resource. The substantive questions and a summary of responses given are provided below.

Figures give no. of responses & mean response (on scale 1-4, where 1= most experienced and 4=least experienced)

3. How experienced are you in using:
a) Computers in general 13 • • • • 2.00
b) The World Wide Web (WWW) 13 • • • • 1.77
c) Research Methods 12 • • • • 1.67

4.a) Did you find it easy to move around the site? 13 • • • • 2.69
b) If not, where/how did confusion arise?
Comments:
- *inexperience and pathways to answers*
- *no knowledge of the meta language of Research Methods*

5. Were the materials and resources sensibly structured and easy to find? 13 • • • • 3

6. Was the appearance of the site (graphics, layout) clear and helpful? 13 • • • • 2.92

7. Do you now have a good idea of what the site is about, what it's trying to do? 12 • • • • 3.08

8. Please rate the quality of the individual materials on the basis of what you have seen today:
a) Self Study Learning Package for the Social Sciences 12 • • • • 3.00
b) Links to other sites:
overall rating 10 • • • • 3.10
Comments?
"a bit difficult to access some sites: perhaps need more than 1 hour
insufficient time to analyse for Q8"

9. Overall, do you think you have benefitted from the tutorial today? 13 • • • 3.46

10. Do you see ReMOTE as being a useful resource in the future? 13 • • • 3.46

*11. What do you **dislike** about it? Please note any improvements or additions which you think might be made.*
Would prefer internet tutorial first
Perhaps better signposting for questions - more explicit
Sometimes it was slow, but overall fairly friendly

The first of the questions above (question 3) illustrated the lack of technical and subject experience of the group. While most indicated a small degree of experience with computers in general only 2 indicated a greater degree of competence. As the tutorials took place prior to their introduction to the Internet and most of the familiarisation with IT this was not surprising but this low self-perception of technical capability did not appear to produce significant difficulty in using the tutorial materials.

In response to question 4 on how easy they found navigation around the site the majority of students reported little difficulty (and where they did they related this to their own inexperience) and similarly they were highly satisfied by the structuring of the resources and the general clarity of the site (Questions 5 and 6). Generally most students responded positively to a general question asking them if they were clear about the aims and objectives of the site (Question 7). They were similarly positive about the materials presented but noted that they were given insufficient time to

explore links contained within the site - generally because of the slow speed of the Internet connection (Questions 8 and 9). Overall the students were satisfied that they had benefited from the tutorial (though noting the significant role of the supervisor in helping them to achieve success) and almost uniformly they saw the resource as being useful in the future (Question 10). The main negative factors noted by respondents in question 11 were generally linked to technical issues and the need for more extensive training on using Internet resources. Informal responses made verbally included comments on the need to use computers at all (one mature student) and the importance of assistance from the supervisor.

Evaluation in PhD tutorial sessions

In order to broaden the evaluation's base, a scheduled class for the instruction of PhD candidates in "Using the Internet for Research" was used as a further testing ground. A longer period was available in which to demonstrate the site than in the previous tutorials (3 hours, as against 1 hour previously) and as PhD candidates the attendees could reasonably be expected to take a genuine interest and participate fully. The site had also been redesigned since the previous evaluation but these were largely associated with design issues and should not impinge on providing a comparison between these students and the earlier group.

13 attendees were present, and a total of seven completed questionnaires were received. The evaluation was administered in the same manner as with the previous tutorials, with the exercise portion slightly modified to be more universally applicable to the range of disciplines represented on the day.

Surprisingly the research students showed varying but generally low levels of technical experience. The WWW was entirely alien to most present, and also, more surprisingly, a general lack of familiarity with Research Methods was also evident.

Generally the research students had difficulty in orienting themselves within the site but almost uniformly found the materials on Research Methods useful, and the appearance of the site clear and helpful. They had no problem in recognising the aims and objectives of the site (as one would expect from this particular group).

Lack of time to investigate the resources fully was again noted: time was intrinsically limited, and it was also some users' first experience with the WWW, indeed in one case with IT of any sort. Overall the students felt they benefited significantly from using the materials but once again, the presence of tutors (two this time) undoubtedly enhanced the users' experience and enabled them to get much more out of the session than would otherwise have been possible. It would, however, have been unwise to let a student's first experience of the site, and in many cases the Internet - and in some cases, of computers - be unsupervised.

When asked to comment on negative aspects of using the site again the main problems noted were technical (relating to the speed of internet connection) and related to time constraints.

Evaluation through self study

This stage of evaluation was intended to test students' ability to use ReMOTE independently after a brief introduction. The same exercise and feedback form were provided to the postgraduate Electronic Information Management class, with a two week period allowed for completion. The exercise was made available by WWW download to allow those who did not attend the introductory class and anyone who might have mislaid the exercise to get it easily. The availability of this download was announced by e-mail immediately after the introductory class, and a reminder issued two days before the due date. The course lecturer also issued reminders in class. However, in spite of repeated requests from lecturer and evaluator, no students reported on their use of the site. One student did register interest through the online feedback form, but expressed no opinion of the site itself. This confirmed that purely voluntary feedback cannot be relied upon.

Online feedback and analysis of use

The ReMOTE site includes a request for online feedback asking for user opinion and suggestion. A number of users from RGU, other UK HEIs, the USA and France registered as having used the resource. As one would expect, written feedback was generally very positive.

The server log files reveal that use of the site has grown steadily since June, although it had not been formally launched at the time these statistics were gathered:

June:	158
July:	79
August:	112

September:	232
October:	225
November:	308
December:	317

Feedback from inside and outside the university reveals that the resource has been "discovered" by many at whom it was not explicitly targeted. A brief analysis shows users from all over Scotland, the UK, Europe, the Americas and Asia accessing the site. The most frequent individual site from which ReMOTE is accessed is Loughborough University, from where access to ReMOTE is almost daily.

Indirect Evidence of Use

A more encouraging development was the discovery that all of the postgraduate students had in fact returned to the resource and found it useful. This came to light during marking of assessed exercises in which some students cited ReMOTE as the source of information. Although difficult to assess quantitatively with any precision, ReMOTE evidently proved itself to students as a useful resource in that they returned to it without further encouragement and were able to extract relevant information from it. This may well be evidence of what Draper et al. have termed 'Delayed learning gains' when they state that 'both staff and students often express the view that the important part of learning is not during EIs (Educational Interventions) such as lectures or labs, but at revision time or other self-organised study times'. Arguably this application and transference of learning is perhaps a more valid indication of the success of an educational intervention than any short term gains in knowledge or skills.

Evaluation: Conclusion

Only a very limited amount can be read into the responses from the various groups who took part in testing: the sample size was small and only a "first impression" is usually possible. The formally and informally gathered feedback indicates that the resource is found to be useful, and in several cases assisted students' resource discovery during the course of the tutorial itself. The impression appears again to have been a generally positive one and the evidence of self-motivated use by students outside of any formal tutorial or evaluation process is an encouraging development. It is concluded that while this web resource may prove bemusing or difficult to assimilate in the brief time available in introductory or tutorial sessions, its value increases with longer term self-directed use when there is an actual information need. This could be maximised with further exposure to the resource e.g. through its integration into coursework assignments.

One particular point must be made with reference to the use of technology: particularly in the case of PG/MSc students. The tutorial evaluation sessions occurred at whatever point in the timetable the class was available - in the case of Information Analysis, this was prior to the students' first introduction to the Internet. As such, any evaluation will be hampered by the students' need to get to grips with technology.

Recommendations and issues for further consideration

Site development

As noted above, the directory feature in ReMOTE would be enhanced from the point of view of both of the user and maintainer by the integration of a database for storing the entries and a WWW front end which will make the directory searchable. This will enable greater flexibility, ease of use and functionality. The use of databases on the world wide web should be investigated further: it is envisaged that implementation of such a system would be inexpensive, the only major cost being the time which it would take to set up initially.

Secondly, the requirement for consistency throughout the pages points to the requirement for a system of document management: currently, pages are constructed in a simple text editor with HTML encoding done by hand. This means that any change in the overall design of pages must be individually applied to each and every page affected, a repetitive and error prone process. Software which is capable of developing and using templates which can then be filled with appropriate content would eliminate a considerable amount of low-level repetitive work and make changes much more quickly and reliably.

If large suites of web pages are in the future to be maintained with current information, both of the above issues must be considered: it will not be possible to compete with similar providers, nor to maintain extensive lists of up to date information without an automated system of document management.

Staff Input and Course Integration

The major difficulty with ReMOTE has been finding a place for it within the taught course structure. Pressures on the time of the relevant members of staff and their lack of good quality, reliable access to the WWW has limited their input and ability to decide on how best to exploit the resource. This contrasts with the Electrical Engineering experience described below where close lecturer involvement enabled full integration into a taught course.

Electronic and Electrical Engineering Modules

The School of Electronic and Electrical Engineering has been at the forefront of developing educational uses for the Internet in the Robert Gordon University, producing a wide range of materials under the auspices of the UMI (Use of MANs Initiative) and other initiatives. With a number of new course modules to teach in the approaching academic year, it was found desirable to try to use the WWW and the prior lessons learned in developing web based applications in order to assist in the teaching and learning process: to alleviate some of the load on lecturing staff by providing materials which could convey information which would normally require an in-person explanation or demonstration; and to provide a resource for the self-study of Personal and Mobile Communications which would enable supplementary work to be done outside of class time, giving access to basic, essential information, to illustrate through the use of the capabilities of the WWW certain concepts, and to provide access to sources for further reading.

The modules in question: *Personal and Mobile Communications* and *Broadband Networks* form an essential part of postgraduate MSc courses in the School of Electronic and Electrical Engineering. While much material already existed for Broadband Networks, the Personal and Mobile Communications Course was essentially undefined at this stage, and the WWW module was to be developed in parallel with the taught course.

In many ways the creation of these units was seen as a more straightforward process - although in terms of work involved in developing the teaching materials they posed a considerably greater workload. As Benyon notes there is still little published material which provides specific guidance on designing teaching materials for the WWW although the existing body of publications on hypertext and hypermedia should in theory provide a solid foundation for this. In order to ensure that the development could be completed within the time constraints imposed by the project an existing framework for unit development was adopted. This was not an ideal solution and ideally the project team would like to have explored and experimented with some of the ideas and issues raised by Mumford, Andrews, Schneidermann and Uys which provide general advice and guidelines. The development approach was based on rapid prototyping and effectively formative evaluation was ongoing throughout the construction of the CAL materials. This obviously was to have a marked impact on evaluation of the packages.

Broadband Networks

The first module to be tackled was Broadband Networks: much of the content and structure of this was already designed, with the overall design adhering closely to the guidelines for module development drawn up by the School during their involvement with the UMI initiative. Essentially, the bulk of the task was a raw conversion of paper based materials onto the WWW and the incorporation of WWW features which would exploit the medium more effectively e.g. use of colour, graphics, animation.

Much of the material was able to be gathered from texts on the subject, as the lecturer concerned has published extensively in the field. There were therefore few problems in identifying suitable materials or deciding on structure or content. The major requirement was for the identification of alternative methods of representing information which exploited the WWW to its best effect.

Personal and Mobile Communications

The initial expectation was that existing paper based materials were to be used as the basis of the resource. However, due to the departure of the lecturer responsible for teaching the subject, the material had largely to be gathered and selected from a variety of texts available on the subject and from whatever other sources could be found. The outline specification of the module was made by the lecturer and was subsequently adapted throughout the development process in conjunction with the developer.

The work required from the developer was more extensive and in-depth than had first been envisaged, since it now involved a considerable

amount of resource selection, acquisition and evaluation in an unfamiliar field. The lack of development guidelines in this area is a serious problem.

Evaluation

This unit was only undertaken by 1 student - an event which could not have been foreseen by teaching staff when the unit was being developed. However, it was felt that it was important nonetheless to attempt to gain some feedback. Evaluation was conducted by interview with the student taking the module, using an LTDI evaluation proforma, and supplementary feedback proforma (also from LTDI). The student proved willing to participate extensively in evaluation and offered in depth observations and opinions on all aspects of the resource. The interview session extended into a valuable 3 way discussion between student, lecturer and interviewer on the merits of the resource and areas for greater emphasis and further development. It was noted that the student copied and took the WWW pages home to study on his own computer, thus negating any design issues dictated by the specification of computers available at the university and communications problems.

Student Overall Impression

The student's overall opinion was that the resource was good, with a few aspects which required sorting. The lecturer and interviewer agreed broadly on this evaluation, and were happy with the module and the recommendations made for its improvement. Some changes were technical, textual or layout alterations which could be effected immediately, others were valid suggestions for extensions in coverage which could be addressed with only a little more research and effort in implementation.

Lecturer's Impression

The lecturer's own opinions and impressions were also sought. Apart from the obvious continuous feedback process resulting from his close involvement with the module's development and use, it was decided to formalise these. A number of feedback forms (LTDI proformas) were completed. One such proforma is reproduced here.

Software usability evaluation

Lecturer's responses in bold, underlined text: *(1 = strongly agree, 5 = strongly disagree)*

I found this package easy to use 1 2 **3** 4 5 6

I would like to use this package again
1 2 3 4 5 6

I would feel confident using this package with students **1** 2 3 4 5 6

I think my students would enjoy using this package
1 **2** 3 4 5 6

I think my students would benefit from using this package **1** 2 3 4 5 6

I think that my students would find this package easy to use 1 2 **3** 4 5 6

I think that the material in this package would be challenging for my students 1 2 **3** 4 5 6

I think that this package contains material similar to my course content **1** 2 3 4 5 6

I think that this package contains material which is desirable pedagogically 1 **2** 3 4 5 6

I think that this package could be useful as a tutorial aid 1 2 **3** 4 5 6

I think that this package could be useful as a lecture aid 1 2 3 **4** 5 6

I think that this package could be useful as part of students' directed study 1 **2** 3 4 5 6

I think that this package could be useful for students encountering difficulties with the subject
1 **2** 3 4 5 6

I think that this package could be useful as a revision aid **1** 2 3 4 5 6

I think that this package could be easily be integrated into my course 1 **2** 3 4 5 6

This package could be useful for more than one course 1 2 **3** 4 5 6

The lower scores concern issues of ease of use, appropriateness for use in other scenarios and the level of "challenge" for students (score on this final issue concurs exactly with student's own opinion). Given that the materials are designed for a specific scenario and the content has in large part been determined by the needs of the course itself, the only area of actual deficiency in the lecturer's eyes appears to be some awkwardness in using the

package: this may be an issue of clarity, given that some screens contain a large amount of information.

Usefulness as a revision aid is borne out by the student's stated response that he found it most useful "as a backup, reference and revision source... at any time and place in the future".

Evaluation: Conclusions

Evaluation of the resource was positive from all sides, with enthusiasm from the student and a commitment from the lecturer to continue updating and using the resource as an integral part of the taught module.

P&MC's development and implementation illustrate the other side of the coin: in contrast to ReMOTE, P&MC was developed with the full involvement of the lecturer concerned with a definite purpose and end product in mind. This has resulted in a deliverable which matches his needs closely and will form an integral part of the course in the future.

One drawback was evident throughout the process: the bulk of development work required the acquisition of suitable materials, and selecting these required an understanding of the subject, which was not a part of the developer's expertise. Consequently, the developer spent much time trying to "become an expert", a time consuming process which meant that both lecturer and developer needed an extensive subject understanding. The division of labour was much less clear than initially envisaged: the intention was to convert existing materials into another format, but proved much more complex, time consuming and demanding. In essence, it was found that the representation of existing materials (or more relevantly, *knowledge*) in alternative formats requires the conversion to be undertaken by a person or persons with a good understanding of both the subject in hand and the medium in which it is to be represented. The implications are not all negative: in the case of P&MC, the developer acquired much knowledge of a subject which would otherwise have been unavailable. This might be exploited in future collaborative projects, where knowledge or skill transfer is a desired outcome - persons with skills in resource development might be given conversion/development tasks in subjects in which they need to increase their understanding. A useful knowledge transfer between the resource developer and subject expert is possible in such cases, and, it could be argued this provides an indirect measure of the success of the project.

General conclusions and recommendations on Conducting Evaluation Procedures

1. More than one evaluation stage is required. "First impressions" gained in a particular environment under certain constraints, plus a raw analysis of usage statistics do not give a full picture. Only through encouraging the further use of the site through integration with taught courses and examining student attitudes after a period of exposure will an accurate and meaningful evaluation be possible.
2. In-class tutorials are subject to the level of student attendance, reliability of the technology and time restrictions. An alternative action plan must be available to cater for non-attendees and those who wish to complete work at a more leisurely pace. This plan must be specified and made known to the class (present and not present).
3. A deadline for post-class completion must be set and any materials required on the day must be announced and available to the students to pick up if they miss the class or lose the materials (e.g. downloadable from WWW, or better still, mailed personally to each student).
4. Testing should take account of all the scenarios in which the resource is to be used e.g. in class and self-study. What may be achievable in class may be more difficult for independent learners. Advance consideration of this is required e.g. class announcements, reminders, integration into homework etc.
5. Where user performance is tested as a means of evaluating a resource, careful thought must be given to the test itself to ensure that it does not contribute to user confusion: a requirement for plain language with adequate signposting which explains its purpose clearly. Ideally we should be using a student's reflection on his/her performance as a critical measure and build evaluative systems which take this into account.
6. Such developments should be introduced as an integral part of the course, taking account of existing schedules and any prerequisite learning e.g. introduction to the WWW should occur before student evaluation of, or introduction to, a WWW resource.
7. Evaluations are subject to student participation: it is often difficult to enforce the filling in of feedback sheets, and this will only be done if the student feels he/she has good reason - and the

time - to do so. We need to look at mechanisms to get critical evaluation of an assured level of quality.

There are ongoing problems in accessing the materials, primarily server availability. There must be some consideration given to solving the technical problems which inevitably arise during WWW use. In a tutorial scenario, services must be reliably available at the time allocated; in a self-study scenario, access may be required at any time and use must not be discouraged by loss of service. Communication between users and those responsible for server administration is essential.

Concluding Remarks

The projects described above do not claim to have 'revolutionised teaching'. They have, however, introduced technology to staff and students and explored some of the issues of integrating that technology to provide sound learning outcomes. The project has given us considerable experience of how to produce materials efficiently but the real challenge which remains is how we can use such resources effectively.

Accessing the sites

At the time of writing the sites are in their initial release states: they have been announced to, and are in use by staff and students within RGU. There are some access restrictions placed on certain materials which are for use within RGU only, in order to ensure copyright compliance.

- The ReMOTE site can be found at URL:
http://jura2.eee.rgu.ac.uk/dsk5/research

- The Personal and Mobile Communications site can be found at URL:
http://jura2.eee.rgu.ac.uk/dsk5/eee/mobile%20comms/pmc1.html

- The Broadband Networks site can be found at:
http://jura2.eee.rgu.ac.uk/dsk5/eee/bbnhome.html

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