SHOULD WE BE USING WEB-BASED LEARNING TO SUPPLEMENT FACE-TO-FACE TEACHING OF UNDERGRADUATES?

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ABSTRACT
There are several pressures to use web-based learning to augment traditional undergraduate teaching, not least of which are to fulfil students' expectations, to increase student retention and improve progression rates.
This paper describes the use of this technology to supplement the face-to-face teaching of a Pharmaceutical Microbiology module delivered to second year MPharm undergraduates, studying full-time on-campus. In particular, it focuses on the use of web-based material to better prepare, and to optimise the productivity of, students undertaking laboratory sessions, material to improve their numeracy and material to tutor them for their end-of-module written examination. Data are presented showing student reaction to the use of this WBL and its impact on their attainment and their attendance at classes. Other issues discussed are lecturers' resistance to adopting this technology and the problems of student accessibility in the context of future hardware trends and, in particular, the migration of software to work on the new generation of Personal Digital Assistants.

KEYWORDS
Web-based learning, e-learning, m-learning, pharmaceutical microbiology, pharmacy students, virtual learning environment, WebCT, PDAs

INTRODUCTION

Web-based learning (WBL) has obvious benefits for learners studying at a distance but can also offer a range of learning opportunities for full-time, on-campus undergraduates, many of whom may need help to increase their commitment to learning. The use of WBL in undergraduate curricula is being driven by:

- the rising expectations of students to use this technology in their learning in today's knowledge economy - and their perception that it is "sexy";
- the benefits it can offer to on-campus, as well as distance, learners;
- the need to teach increasingly large and diverse groups of students;
- the need to offer learning flexibility to the increasing number of full-time students who also have part-time jobs;
- the need to compete with other providers of higher education that are not necessarily traditional on-campus universities;
- the use of this new technology being implicit in the Dearing report (Dearing, 1997);
- university strategic plans for learning and teaching where the adoption of this technology is explicit.

These, and other pressures, are variously discussed by Maier and Warren (2000), Ryan, Scott, Freeman and Patel, (2000), Forsyth (2001) and Cornford and Pollock, (2003).

This paper describes a number of web-based programs written by the author which he uses to augment, rather than to replace, traditional face-to-face teaching of pharmaceutical microbiology to his second

year undergraduates on a full-time, 4-year, MPharm course. Students can access the material both on- and off-campus from within a WebCT virtual learning environment.

Data are presented which show student reaction to this material, their level of commitment to the module and their attainment.

MICROBIOLOGY PRACTICAL TUTOR

The production of this tutor was born out of the necessity to provide one particular cohort of students who, by force of circumstance had done no previous Microbiology, with a primer for undertaking a microbiological assay of penicillin. Moreover, the laboratory time had been reduced to 2hr from the customary 3hr. Image-rich web-based material was produced showing each step in the experiment, together with the results expected and the technique for using the Vernier-scale callipers to measure the zones of inhibition produced (see Figure 1). Students were required to work through this material prior to attending the laboratory session.

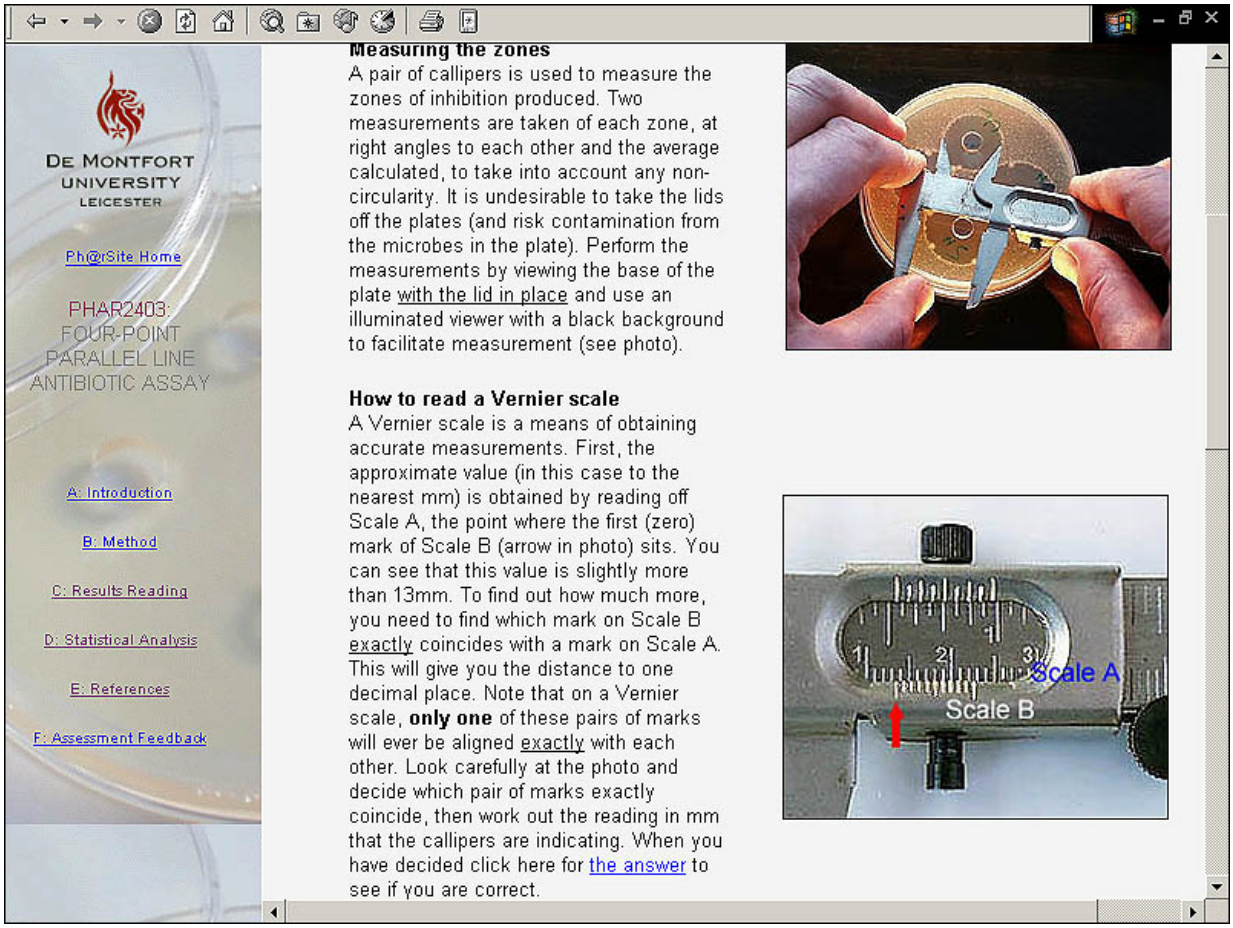

Figure 1. Web page from the Microbiology Practical Tutor dealing with antibiotic assay

This approach proved to be so successful, that *all* the author's laboratory sessions are now accompanied by supplementary WBL material. This includes interactive elements such as quizzes, pause-for-thought questions and links to relevant external websites on the Internet which students work through, prior to the laboratory sessions. This material is in addition to the traditional printed laboratory schedules.

Providing supplementary web-based learning material for the practical classes:

- better prepares students for each laboratory session so that they work more confidently and efficiently;

- reduces tutor talk time at the beginning of the class;
- enables expected experimental results (both positive and negative) to be shown using high quality images to help students interpret their own data;
- offers student-centred learning on other external websites, thereby placing the experiments into context.

Table 1. Student comments on use of the Microbiology Practical Tutor

"This way of introducing the practical material ensured that every student had read and understood the practical before commencing."
"Practical tutor helped in practicals a lot."
"The practical tutor was excellent for information about the forthcoming practicals but gaining access to them was sometimes difficult and very time consuming if there was no Internet access at home."
"The web site helps visualise the observations that would be seen for the tests, helping in gaining a better understanding of the experiment."
"The web-site helps explain and break down the practical session. It is clear and concise and did improve my knowledge about the techniques employed during the practical session."
"The Microbiology Practical Tutor and the Dangerous Microbes Program were very good. Study would be a lot easier if all lecturers had a web-site like this."
"The web site was a different way to aid learning and encouraged more effort to be put in to preparation for the labs."
"Quite helpful for practicals to see results of test in picture form, so that we know what is expected, as well as apparatus being pictured."
"By using the web-based programs, I found the practicals more understanding and beneficial to the course."

The web format allows high quality full-colour images to be used at minimal cost, whereas providing such material in paper-based format would be prohibitively expensive.

MICROBIOLOGICAL CALCULATIONS TUTOR

An ability to correctly complete simple calculations is obviously important to prospective pharmacists who, eventually, will have to correctly calculate drug doses. To help to combat the increasingly poor numeracy skills of current intakes, the author has written a Microbiological Calculations Tutor which students are required to work through prior to undertaking a summative, time-constrained, test without the use of calculators. A similar set of calculations also forms one short question in the end-of-module unseen written examination paper.

Students can either attempt to answer each question at “first look” or, they can use the “step-thru” facility which helps them to arrive at the correct answer in a series of simple stages (see Figure 2). Each question is accompanied by a short description of the question context, so that students can understand why they might be required to undertake such a calculation.

Students are encouraged to repeatedly use the Calculations Tutor until they can obtain the correct answer to each question at “first look”. The Tutor has been written using JavaScript so that each time it runs, the questions remain the same but the values are changed. After completing a question, the user can either try another calculation of the same type or go on to a different question.

Since this Calculations Tutor is for formative assessment only (prior to students taking the summative spot-test), no record is kept of the score obtained so this remains private to the learner. This helps the student to see the Calculations Tutor as a non-threatening learning tool, rather than a means for the instructor to check on individual student progress.

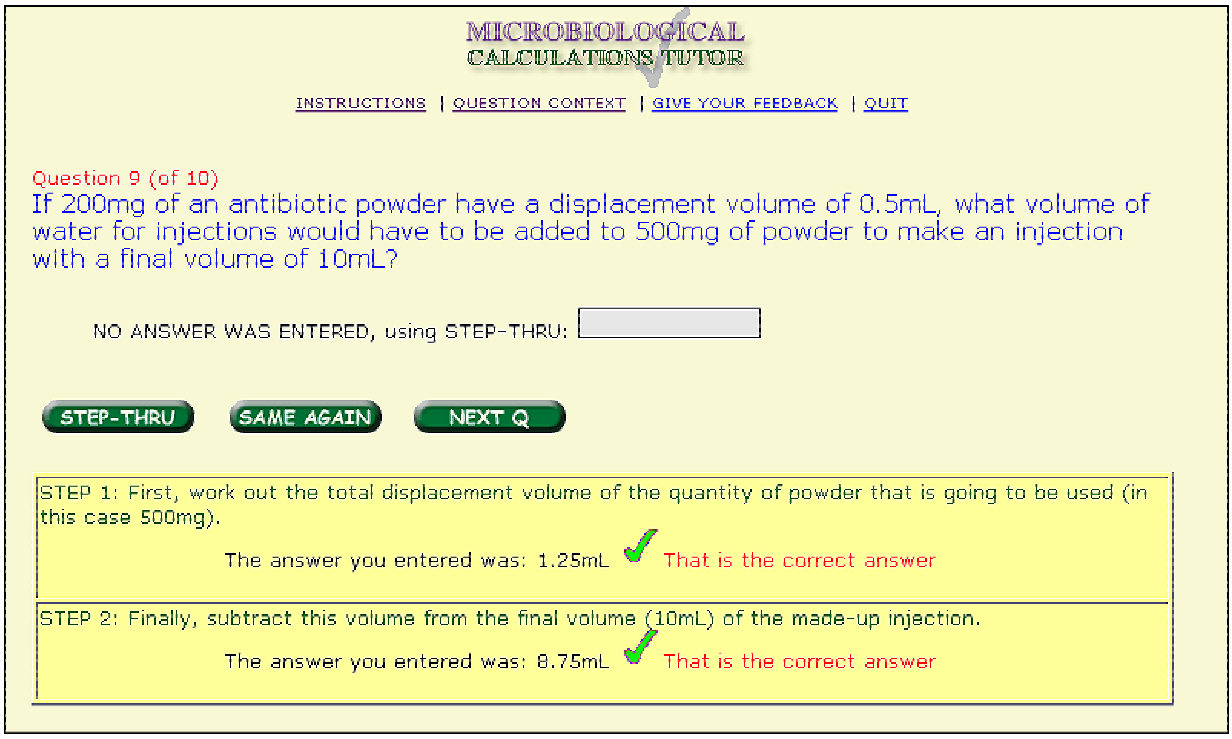

Figure 2. Screen shot from the Microbiological Calculations Tutor

To evaluate the effectiveness of the Microbiological Calculations Tutor, students in the 2002/2003 academic session took the calculations spot test *before* being given access to the program and were then given 2 weeks to use the Tutor to try to improve their performance before taking a similar spot test again. Figure 3 shows histograms of their performance in the two spot tests and in tackling a similar set of questions in the end-of-module examination paper 2 months after the module had finished.

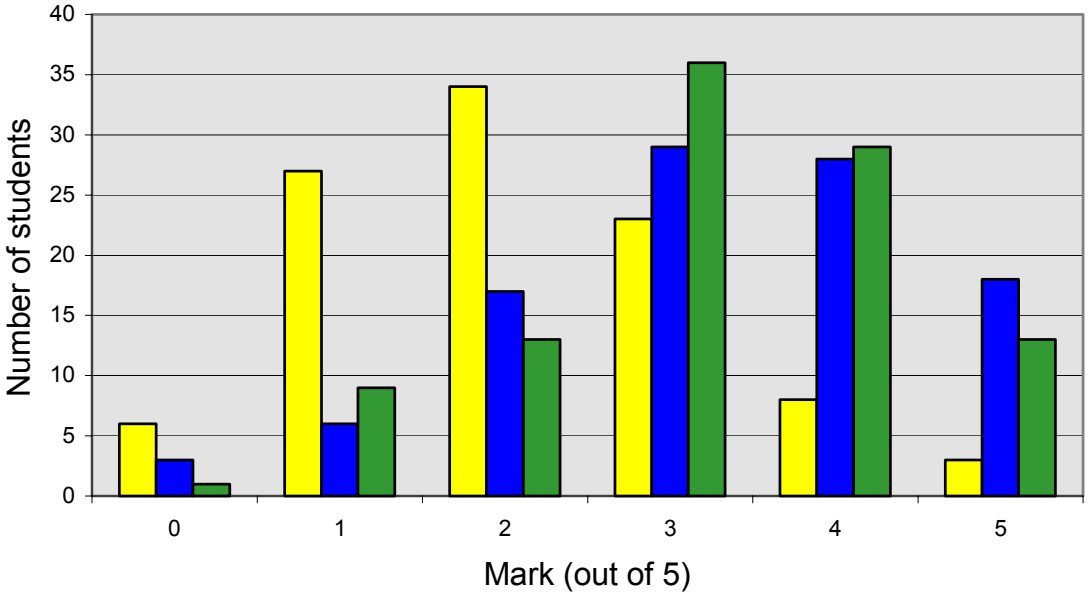

Figure 3. Student performance (*n=101*) in microbiological calculations spot tests before (left-hand bars) and after (middle bars) using the Microbiological Calculations Tutor and in the end-of-module examination paper (right-hand bars)

Using the Calculations Tutor produced an increase in performance in the spot test in 71% of the students, whilst 15% obtained the same mark in each spot test and 14% did worse in the second test. The data in Figure 3 also show that the numeracy acquired by using the Calculations Tutor during module delivery was retained for the end-of-module examination 2 months later. Student comments about the use of this Tutor are shown in Table 2.

Table 2: Student comments on use of the Microbiological Calculations Tutor

"Microbiological calculations tutor was very helpful."
"Computer program was very useful, especially the microbiological calculations tutor."
"The calculations tutor was very good as the answers were given and explained in a very understandable manner. This was good as many modules expect you to excel in maths and not all of us do."
"I found the microbiological calculations tutor very good."
"Calculations changing each time you do program is very useful and good practice."

The advantages of providing these calculations in web-based format rather than, say, as paper-based media, are that it facilitates interactivity and randomisation of question data and enables instant feedback to be given to the learner. Moreover, time-constraints can easily be built into the package to emulate the test situation.

INTERACTIVE SPECIMEN EXAM PAPER

Successful completion of the module involves obtaining a minimum of 40% in both the coursework and in an end-of-module unseen written examination paper, which consists of 10 short answer questions and 30 multiple choice questions (MCQs). To prepare students for this exam, an interactive specimen

exam paper has been provided (Figure 4a & b). This introduces the format of the paper and allows students to complete specimen answers on-screen if they so wish.

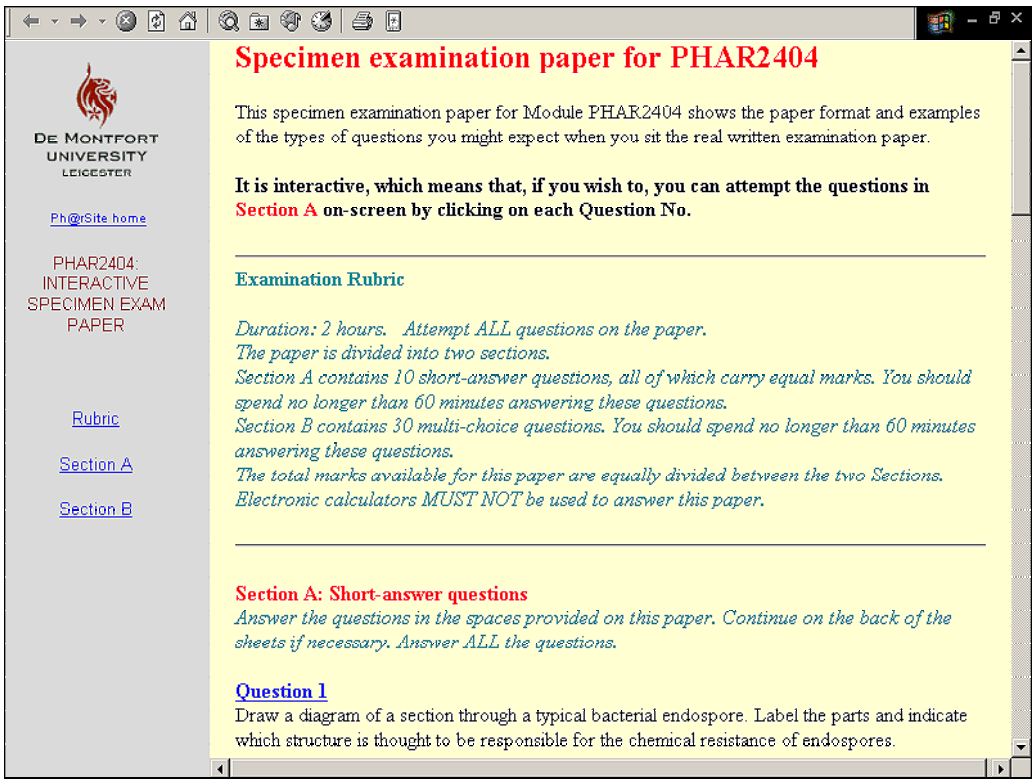

Figure 4a. Screen shot of Specimen Examination Paper

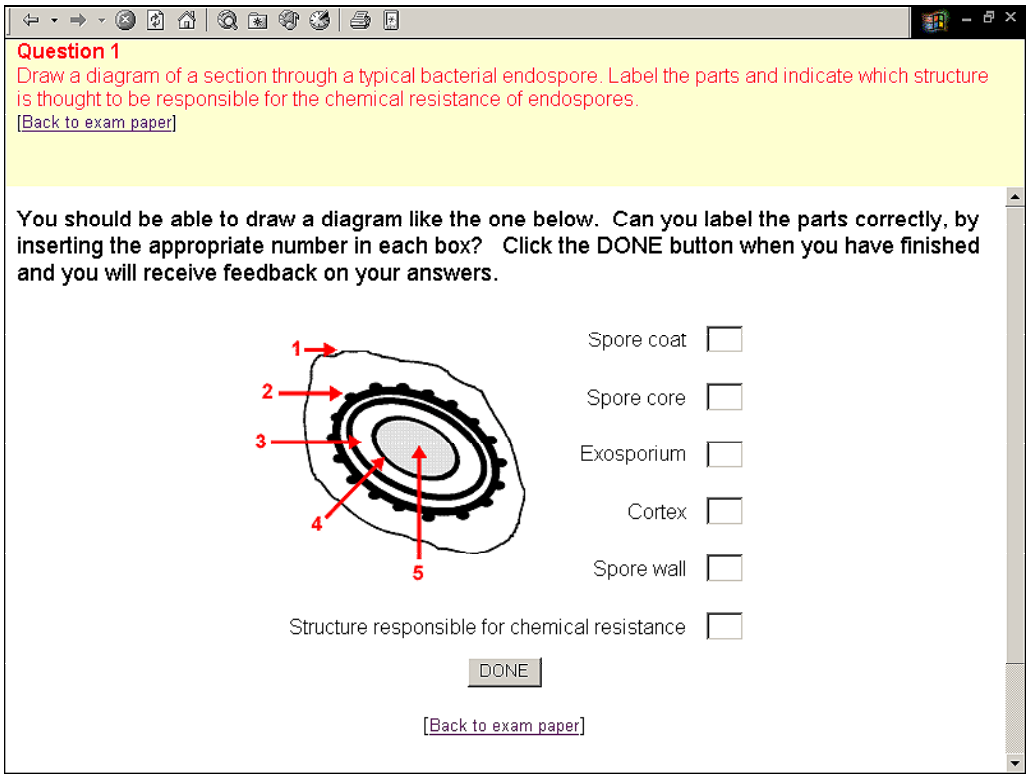

Figure 4b. Specimen answer for Question 1 which the user is invited to complete

Practice in answering the MCQs on the paper is provided by a separate MCQ Tutor, which also allows students to experience the effects of negative marking.

Besides the online learning facilities described above, other areas of the module website include:

- a description of the assessment criteria;
- a list of learning resources and links to external websites;
- a discussion board facility;
- lecture presentations in PowerPoint format and in a printable text-only format (which students bring to the lectures);
- an extensive feedback section which gives general tutor feedback and comments on students' attainment in coursework and exam and a summary of student feedback on the quality of the module (from the generic university module feedback questionnaire).

STUDENT REACTION TO THE WBL

In the main, students have been very positive about the module website. In anonymous surveys of 5 cohorts of students, most have been very appreciative of the supplementary WBL material, expressing the wish that other modules provided similar material. Table 3 shows a summary of the results of these surveys for the last 5 years where students were invited to respond to statements using a 5-point Likert scale, ranging from strongly agree to strongly disagree.

Table 3. Evaluation of WBL material by 5 cohorts of students

Statements	**Percentage of students agreeing or strongly agreeing with each statement**				
	1998/99	1999/00	2000/01	2001/02	2002/03
	n=81	*n=89*	*n=79*	*n=82*	*n=103*
A) It enhanced my learning experience	95	86	96	89	91
B) It was clear and easy to use	96	95	97	93	93
C) It was of the appropriate intellectual standard	89	90	91	88	93
D) I liked learning in this way	56	44	64	63	62
E) It increased my interest in Microbiology	47	44	44	46	39
F) It increased my confidence in using computers	63	44	46	41	42

These data show that a high proportion of students felt that the WBL material enhanced their learning experience, that it was clear and easy to use and that it was of the appropriate intellectual standard (Statements A-C). Some students were less enthusiastic than others about this method of learning (Statement D), but this is not an uncommon finding (French, Hale, Johnson and Farr, 1999). In common with the findings of Saunders and Klemming (2003), only a minority of students used the website's discussion group facility.

The main dislike voiced by the students was that the WBL increased their workload. Whilst it would have been nice if the figures for Statement E had been higher, the author takes the view that to increase the interest of over 40% of the students is better than nothing. Some students said that they were already interested in Microbiology irrespective of the existence of the website. In talking to the students, the majority felt that they were already sufficiently competent in using computers before they encountered the author's website (Statement F). This may also reflect the success of a previous

module in which computer and Internet skills are taught. Looking at the data in Table 3 as a whole, there is a striking consistency in the responses provided by the 5 student cohorts.

STUDENT ATTENDANCE & ATTAINMENT

Attendance at classes has been extremely good. Table 4 summarises the attendance rate at laboratory sessions and tutorials for 5 student cohorts (attendance at lectures is not compulsory).

Table 4. Attendance rates at laboratory classes and tutorials

Session	Absences	Attendance rate
2002/2003	2 absences in 1339 attendances*	99.8%
2001/2002	3 absences in 1066 attendances	99.7%
2000/2001	1 absence in 1027 attendances	99.9%
1999/2000	7 absences in 1157 attendances	99.4%
1998/1999	2 absences in 1053 attendances	99.8%

*Calculated by multiplying the number of classes by the number of students in the cohort

In terms of attainment, only 1 student from the 5 cohorts featured above (434 students) has failed the coursework element of the module. In the unseen written examination, 39 out of 434 students failed to obtain the 40% pass mark at their first sitting, representing a very respectable pass rate of 91%. To date, all students have passed the exam at their second attempt.

WEBSITE ACCESS

Students have made good use of the module website, accessing it at all times of the day and night, including public holidays such as Christmas Day and Boxing Day. Clearly, some students will not have Internet access off-campus so on-campus provision needs to be adequate to avoid disadvantaging this student group. Table 5 shows the results of an anonymous survey on access issues.

Table 5. Questionnaire on website access for the 2002/2003 Session *(n=103)*

	Yes	No
1. Do you have **off**-campus access to the module website during term time	55 (53%)	48
2. If you answered "Yes" to Q1, do you access the module website off-campus?	47 (87%)	7
3. If you do not have off-campus access, do you feel disadvantaged?	31 (76%)	10
4. Do you have off-campus access during vacations?	81 (79%)	21
5. If you answered "Yes" to Q4, do you intend to access the website during the vacation?	76 (96%)	3
6. Are the university facilities sufficient for you to make good use of the web-based learning material for this module?	91 (90%)	10
7. When you logon to the module website **on**-campus, are you able to access it without encountering technical problems?	86 (89%)	11
8. When you logon to the module website **off**-campus, are you able to access it without encountering technical problems?	39 (93%)	3
9. Do you have your own mobile phone?	100 (97%)	3
10. Do you own a PDA (i.e. a Personal Digital Assistant/Handheld computer)?	4 (4%)	99

About half the students have Internet access off-campus. This is similar to the proportion of students with off-campus access in previous cohorts (author's unpublished data) and slightly less than the figures supplied by Saunders and Klemming (2003) in a similar survey.

Three quarters of students not having off-campus access felt disadvantaged (Q3). However, somewhat paradoxically, of these 31 students, 29 of them considered the university facilities to be adequate for them to make good use of the website (i.e. they answered "yes" to Q6). The overall satisfaction with the university facilities (90%) and the lack of technical problems encountered when logging on (89% on-campus; 93% off-campus) are considered to be highly satisfactory.

THE FUTURE OF e-LEARNING

The future of e-learning may lie in m-learning (mobile learning) where the WBL material is presented on a handheld device. Several groups of workers have explored the use of Personal Digital Assistants (PDAs) for this purpose (Riera, Vila, and Barro, 2001; Rodriguez, Nussbaum, Zurita, Rosas and Largos, 2001) and the author has re-written several of his programs to operate on a Compaq Ipaq PDA, running on the Microsoft PocketPC 2002 platform. Whilst only 4% of the students surveyed in Table 5 presently own a PDA (Q10), 97% of them own a mobile phone (Q9). PDAs with integral mobile phones are now appearing in the shops and the author sees these as a potential means of increasing student access to websites, allowing WBL to become independent of university facilities.

CONCLUSIONS

Supplementing traditional methods of delivering face-to-face learning with WBL is attractive because it:

- provides a central resource of information that the learner can access at their choosing ("always-on learning") and work through at their own rate;
- can be image-rich, truly interactive and can offer instant feedback and individualised learning;
- facilitates the tutor maintaining currency of information;
- can include an alterative means of communication outside "office hours";
- can be a vehicle for encouraging collaborative learning;
- obviates the need for tutors to provide paper-based materials for students.

The main disadvantages are:

- the expertise and time needed to produce high quality WBL material, which has been estimated to be as much as 200 hours for 1 hour's worth of learning (Dearing, 1997);
- the cost of providing an infrastructure to deliver and support "always-on" learning, particularly if a virtual learning environment, such as WebCT, is being employed;
- over-reliance by the learner on WBL to the exclusion of other methods of learning (e.g. using textbooks, journals);
- the need for the tutor to remain familiar with his/her website and keep it maintained;
- information overload and the danger of the learner being unable to discriminate between reliable and unreliable sources of information on the unregulated Internet;
- passing printing costs on to the student.

Despite the disadvantages, the author firmly believes that tutors should seriously consider using WBL to supplement face-to-face teaching of their undergraduates. Ideally, WBL material should be interactive, exploit features of the medium not found in other formats and enable students to do things that could not be done before in another way (for a fuller discussion of these points see Graham, McNeil and Pettiford, 2000; Horton, 2000; Jolliffe, Ritter and Stevens, 2001). These criteria are unlikely to be satisfied immediately a tutor begins to explore the use of WBL particularly if, through necessity, the material is self-produced rather than being produced by a team including web designers and instructional designers. The main hurdle is to get staff onto the first rung of the e-learning ladder.

Initially, this may simply consist of a tutor posting lecture notes and booklists, albeit that this has been condemned as a misuse of the Internet for course delivery (Forsyth, 2001). Jackson (2003) discusses "ten challenges for introducing web-supported learning" into the curriculum.

The reticence of academic staff to adopt new technology in the classroom is well known (Horton, 2000) and the author's institution is no exception. In a survey conducted by the author of 53 academic staff within the Faculty of Applied Sciences, a mere 14 staff (26%) were using WBL to teach undergraduates and this mainly consisted of pointing students to material already on the Internet. As might be expected, the main constraints to adopting WBL to supplement teaching were cited as lack of time and resources (34 staff; 64%) and unfamiliarity with the technology (26 staff; 49%) despite the fact that 45 staff (85%) expressed the desire to use WBL in the future.

It has been suggested that supplementing face-to-face delivery with WBL (rather than using it for distance learners) may not be worth the effort (Jolliffe, Ritter and Stevens, 2001). Others have debated that virtual learning may pose a threat to the traditional university (Cornford and Pollock, 2003). In the author's experience, the WBL material he has produced to supplement his module has provided an enriched learning experience for both his students and himself, and is worth the acknowledged cost in terms of an increase in his workload. Rather than being a threat to the traditional university, he sees it as simply another means of delivering undergraduate learning that *augments* rather than replaces traditional methods of delivery and meets the expectations of today's learners.

Note: The full PowerPoint conference presentation of this paper can be viewed at http://www.appsci.dmu.ac.uk/mhea/cblis2003/

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