6 Introducing Technology onto a Traditional Course: Turning the Classroom Upside Down

Gunter Saunders

University of Westminster, 9-18 Euston Centre, London NW1 3ET, UK
saundeg@wmin.ac.uk

Abstract

This paper reports on the integration of a wide range of information and communication technology (ICT) tools into an undergraduate module in biosciences. The aim of the integration was to shift the balance of talk during classroom sessions, away from the lecturer and to the students. Over the four-year period covered by the data presented two distinct approaches to achieving this aim were taken. One of these exploited the use of a web site to facilitate preparation for face-to-face discussion during classes. The other relied on the use of asynchronous threaded discussion boards to promote interaction outside of timetabled classes. In the latter approach classroom sessions were used mainly for group work and to provide one-to-one feedback to students. In both approaches traditional lecturing was reduced to virtually nil. Both approaches were on the whole welcomed by students and tutor. However it was clear that during the semester, the majority of students only made use of the electronic tools and materials provided when they were needed for the completion of assessed coursework.

1. Introduction

Larger class sizes, coupled to a more diverse student population have both acted as stimuli in recent years for an examination of approaches to teaching and learning (Bourners and Flowers 1997; Saunders 2000). Increasingly such examination is leading to attempts to more effectively exploit ICT so as to better respond to a situation where students are finding it increasingly difficult to attend regularly on campus (Hudson et al., 1997; Saunders et al., 1999; Collis and Moonen 2001). Whilst this is a laudable response to genuine student difficulties, such a driver for change can detract from the debate about whether increased use of ICT can actually enhance the quality of the learning experience.

There is indeed much active discussion within the academic community as to the value of ICT in teaching and learning. Whilst it is almost universally agreed that ICT has much to offer distance learners there is much less agreement about the role of ICT to deliver hybrid courses and benefit more traditional campus based students. Those who are ardent supporters of the use of ICT can point at a considerable body of research which suggests it can be effective. Some recent examples include a study of the teaching of mathematics (Wenglenski 1998) which concluded that ICT does promote academic achievement. Many other studies have reached similar conclusions (e.g. Salpeter 1998) but almost all will make the point that the effectiveness of the use of ICT relies heavily on the context within which teaching and learning takes place (Healey 1998).

Critics of the use of ICT are quick to point out the potential pitfalls involved in increasing the use of technology. Some of this criticism relates to the fact that many of the studies extolling the positive features of ICT are extremely context specific and cannot therefore be considered generically applicable. Since many reports of the use of ICT to support teaching and learning now qualify their conclusions within context, it seems as though proponents and critics alike are moving towards the middle ground that suggests ICT can help if used in a way that takes full account of both the subject area and students involved. Despite this what often is expressed as a great concern is that staff teaching at a traditional university will somehow misuse technology, and as a consequence students will experience a worse form of learning.

At the University of Westminster, within the School of Biosciences, a range of ICT tools have been used to progressively increase the flexibility of delivery of a final year undergraduate module in microbial genetics. This module was for many years taught with students receiving a mixture of lectures and tutorials (approximately 70% lectures and 30% tutorials with 1 member of staff to support around 30 students). The most obvious change in delivery brought about by the integration of ICT tools has been the effective loss of all 'traditional' lecturing on the module (for the purposes of this paper traditional lecturing is considered to be an event where one person does all or most of the talking). Over a period of four years the lecturing formerly done has been replaced initially by text based materials and then most recently, recorded slide presentations distributed on CD. In 1998/99 one 30-45 minute 'interactive' lecture was given each week (for the purposes of this paper and interactive lecture is considered to be one where students are encouraged to and make periodic intervention in the teacher talk). This was reduced gradually over the next 2 years until in 2001/2002 only 6 X 20 minutes overview lectures were given. The classroom time formerly used for lecturing has been instead devoted to provision of feedback and other discursive activities such as student led group work.

In each of the four years the mixture of ICT tools used has changed, as increasingly sophisticated the technology has become available and in response to feedback from students. At the end of each academic year concerned the approach taken was thoroughly evaluated. A combination of questionnaires, interviews with individual students conducted by staff not involved in delivery of the module and student led group discussions have been used.

2. Context of module delivery

A module in microbial genetics has formed a part of a number of undergraduate degrees within the School of Biosciences for over 15 years. For most of that time the module has been delivered in a similar way to other modules on the degree. The general approach on the degree is to provide students with a mixture of lectures, tutorials and a few laboratory classes. Generally the emphasis in classroom based sessions has been the lecture. On the microbial genetics module there was no laboratory classes. This is because at this stage of the degree students are separately engaged on their laboratory based research project module. Assessment on the module was also typical of that found for most modules on the degree, comprising a mixture of continuously assessed coursework and an end of module written examination. There were four items of coursework, collectively worth 50% of the module marks, with the final written examination accounting for the other 50%.

Normally the module would be taken by between 30 and 40 students studying one of a number of related degree pathways (for example biomedical sciences, biochemistry and microbiology, biotechnology, medical biotechnology) within Biosciences. The module in microbial genetics comprised one eighth of the final year of study (fifteen credits out of a total of 120 credits for the year). Therefore, the students concerned would typically be taking a further 45 credits, comprising (depending upon the particular pathway they were on) either three further 15 credit taught modules or one other 15 credit taught module and the 30 credit laboratory based research project.

In academic year 1998/99 all timetabled classes except for one took place in a normal classroom. In the other three academic years of this study (1999/00, 2000/01 and 2001/02) all timetabled classes took place in a networked PC laboratory with each student having access to a PC.

In the first year of this study, (academic year 1998/1999) students were provided with a set of web pages comprising notes and exercises for each week of the course. Students were expected to come to each classroom session having read the notes and tried the exercises. In between classroom sessions students were also asked to send the tutor at least one e-mail or question or comment about the forthcoming week's topic. They were encouraged to work in small groups to do this. The content of these e-mails was used whenever possible to shape the classroom discussions.

In academic year 1999/2000 students were also provided with a set of interactive multimedia tutorials covering most topics on the module. The tutorials were designed to complement the notes available on the module website. Typically each tutorial took about 20-30 minutes to work through and comprised a series of screens containing a mixture of text, diagrams and areas for direct student input. Movement through the tutorial was always directly linked to some positive student input. Thus for example a student might see on screen a diagram of a complex biological process and they would be able to reveal information about each stage of the process by moving the mouse arrow through the different parts of the diagram. Movement to the next stage of the tutorial would normally require students to complete an on-screen task requiring either pointing at the correct part of the diagram or entering some text into a text box. These interactive tutorials were made using the multimedia authoring tool called Mediator (Matchware Ltd). Authoring took some time despite the user friendliness of the software concerned. In addition to the interactive tutorials this year also saw the introduction of formative on-line short answer tests to supplement the notes and tutorials.

Typically for each week of the course there was at least one test containing a mixture of multiple choice, multiple response, true false and fill in the blank questions. The on-line assessment tool used was QuestionMark Perception and students taking the tests were provided with instantaneous feedback on each question in addition to their overall score. There was no limit to the number of times a student could take a test. This year also saw the first attempts to use an asynchronous discussion board (actually a Microsoft Frontpage Discussion web) to facilitate communication between students on the weekly topics. In the following year (2000/2001) all of the above were further supplemented with two in-house developed communication tools. One was a web based messaging system that enabled targeted delivery to all students on the module of news and information. The other was an interactive frequently asked question (FAQ) database which allowed students to search amongst an existing bank of categorised questions and answers. However the system also allowed students to ask new questions when they wished to and provided the capability for the tutor to both answer and at the same time add the question and answer to the growing database of FAQs.

In 2001/2002 all module materials and communications between students and between students and tutor, were 'packaged' within the virtual learning environment (VLE) Blackboard. The use of Blackboard effectively replaced the existing module website, the web-based messaging tool and web-based discussion board generated by Microsoft FrontPage. The FAQ tool continued to be used as there was no equivalent within Blackboard, however all on-line assessment was moved from QuestionMark Perception into the assessment system built into Blackboard. In addition, for the first time student use of the asynchronous discussion

boards was assessed. In this academic year a CD containing audio slide presentations, each of about fifteen to 20 minutes duration, and covering all the major topics on the module was also provided to students. The mixture of ICT tools used over the four years are summarised in Table 1.

In all four years the amount of face-to-face contact with students in a classroom or a computer laboratory was not significantly reduced, relative to that which the module contained prior to 1998/99. However, there was no formal lecturing and students were required to either take part in small group work, whole class tutor led discussions or computer mediated learning, assessment and communication. The exception to the general rule of no one (tutor) to many (students) discourse was the delivery by the tutor of a fifteen to 20 minute overview presentation every two weeks. The aim of each overview presentation was to place into context the topics to be covered in the following two weeks and to highlight key concepts that the students should focus on in their self directed work.

ICT Tool/Materials	Function	Academic year(s)
Web site	Providing information, notes.	98/99, 99/00, 00/01
WNN	Web based messaging	00/01
WNF	FAQ tool	00/01, 01/02
QMark	Assessment	99/00, 00/01
Multimedia Tutorials	Promote understanding	99/00, 00/01, 01/02
Recorded slide presentations	Overview of major topics	00/01
Blackboard	VLE	00/01

Table 1: List of ICT tools and materials used indicating their major function and the year(s) in which they were used.

Over the four-year period of study, whilst the number and type of coursework exercises remained largely unaltered, the relationship of the coursework exercises to the electronic materials and tools was changed. In the first and second years of this study, (1998/99 and 1999/00) no explicit link between the coursework exercises and the interactive tutorials was made by the tutor. However in the last two academic years (2000/01 and 2001/02) the subject matter of the coursework exercises was much more closely integrated with the tutorials and students were explicitly told which tutorials to focus on for each coursework exercise. The way in which the use of the ICT tools and materials changed in relation particularly to coursework, is summarised in table 2.

3. Evaluation of the approaches taken

At the end of each year most students completed a detailed questionnaire. The questionnaire sought statistical information about PC ownership and understanding of relevant software and hardware but in addition gave students some scope to describe their overall approach to learning at university.

Academic Year	Ways in which ICT tools were used
1998/99	Course notes/tutorial exercises available on website. Students expected to prepare for classroom sessions and to use e-mail to communicate with the tutor.
1999/00	Web pages supplemented by interactive tutorials on CD, on-line tests for formative purposes and asynchronous discussion board.
2000/01	Coursework for the first time explicitly linked to the interactive tutorials. FAQ tool introduced. To support coursework.
2001/02	Module materials and communications packaged in the VLE Blackboard. Use of asynchronous discussion boards linked to coursework and also directly assessed.

Table 2: Summary of the use of the ICT tools across the 4 years and relationship to coursework and assessment

Inevitably the information students provided on the latter point was limited on the questionnaire. As a consequence feedback was also obtained through interviews with a sample of students from each year (on average 7 students from each academic year were interviewed on a one-to-one basis by a member of staff who had not previously met the students). The main purpose of the interviews was to focus on the ways in which students used the materials and tools provided. As well as these staff led interviews, in 1999/00 and 2000/01 student led discussion groups were also used to gain additional insight into the views of students about the way in which the module was delivered. Although not originally an aim, the student led discussions turned out to be extremely useful in gaining a fuller understanding of the way in which modern students approach their degree work.

4. Student access to essential hardware and software

Apart from concerns about the pedagogic value of ICT, detractors of the use of ICT also often cite the potential problem arising from a lack of availability to students of appropriate hardware and software. Obviously this is a serious issue particularly as most campus based universities are not able to provide anywhere nearly enough computers to satisfy demand, especially at certain times of year when coursework deadlines enter the equation. Accordingly, with the use of ICT to support module delivery on the increase it is often necessary to rely to a degree on students having access to a PC outside of the University.

Over the period of this study, it is evident that student ownership or access to a PC outside of the University has increased substantially. In addition the number of students having access to the Internet from home (including access to the World Wide Web and e-mail) has also steadily increased (see Table 3).

	98/99	99/00	00/01
Percentage with an Internet connection at home	57%	67%	75%
Percentage with PC at home	75%	96%	92%
Percentage making regular use of WWW in their studies	46%	95%	100%
Percentage using e-mail on a regular basis	50%	95%	98%

Table 3: Student access to a PC and Internet connection away from the University and their use of the WWW and e-mail in academic years 1998/99, 1999/2000 and 2000/2001. Figures for 2001/2002 are not presented as they are not significantly different to those for 2000/2001

5. Electronic materials and tools - the overall student view

In all four years of the study it was quite clear that the majority of students welcomed the availability of electronic materials. However it was also apparent that the materials which they favoured most were those that resembled pages of text from a book. In the first year of this study (1998/99) there was considerable concern expressed by the students at the beginning of the module regarding the lack of formal lecturing. Indeed the concern was so great that the issue was raised at the student/staff course committee meeting early in the semester. Interestingly in the last three years no concern was expressed by students taking the module regarding the lack of lectures. However in all four years the students highlighted

the value they found in the brief overview presentations given by the tutor. A majority of students were very clear that the ICT resources and tools were useful as a supplement but not as a replacement for face-to-face activities.

The interviews and student led discussions revealed that whilst many students appreciated the resource materials, very few saw their availability as a reason not to attend classes. However it was very noticeable that attendance in the last three academic years of study, when classes were held in computer laboratories, was higher (80-90%) than in academic year 1998/99 when attendance was usually between 60% and 70%. In that year all classroom sessions were in a normal classroom bar one held in a computer laboratory.

In the student led discussions most students said that they preferred a standard lecturing approach to module delivery. However most also agreed that they saw advantages in the use of on-line materials and tools, and thought that they would be more positive towards this type of delivery method if it had been introduced gradually during the first year at university.

6. Student use of the ICT materials and tools

Evidence obtained from the one-to-one interviews supported the view that most students preferred classroom sessions where they were active. However, relatively few students ever used the ICT materials in advance of a classroom session. In the first year of this study, 5 out of a total of 20 students interviewed stated that they had tried to prepare for classroom sessions as requested by the tutor. However they all pointed out that such preparation became more difficult as coursework pressures on other modules built up and as work on their research project came to a climax.

In 1998/99 and 1999/2000 most of the students interviewed referred to the fact that they listened more during classes whilst very few found that the way the module was delivered had encouraged them to contribute more during face-to-face tutor led discussions. The students who placed importance on listening felt that the availability of the on-line module resources had a significant impact on the classroom experience. One student stated, "I didn't have to panic about writing it all down and was therefore able to listen more". All students who were interviewed felt that such on-line based resources should be used more widely on the degree course.

In all years, students inevitably printed off as much of the on-line resource material as they could. In academic year 1998/99 all of the materials were made available at the beginning of the module. This tended to focus many students on the need to print off everything as quickly as possible. In the last three years materials were provided on a more incremental fashion, and in the last year, on a weekly basis. This need to print made the interactive tutorials, which first became available in

academic year 1999/2000, somewhat unpopular as they were difficult to print out.

The most revealing insights into the way in which the students used the module resources, and indeed the way in which they approached studying at university generally, came from the student led discussions first conducted in academic year 1999/2000. The reports from the two students leading each of the two discussion groups in that year (each comprising 10-12 students) showed clearly that most made little use of the interactive tutorials on CD during the semester or indeed for revision. Equally most students were not interested in using the on-line formative tests during the semester. This was confirmed by the statistics generated by the assessment package which showed that only about 25% of students regularly tried the tests.

The reports from the student-led discussion groups left little doubt that most students spend the majority of their time on the degree course compiling learning resources (notes from lectures, copies of articles, handouts given to them by lecturers). In general such compiled learning resources were not used during the semester unless required explicitly for an assessed coursework exercise. It was frankly admitted by students that unless the compiled resources were needed in this way then they would normally not be looked at until very near to the final written examination. It was clear that the major difference for students with respect to the microbial genetics module was that they essentially generated course handouts themselves by printing material and that in timetabled classes, instead of taking notes, they spent their time listening more both to the tutor and each other. In a sense it appeared that the on-line resources were just like any other compiled learning resource. The only difference was that students needed to work less to compile them. As one student put it, "the majority of us went from not using the module resources at all during the semester to an almost frantic use of the web-based material for exam revision".

In academic year 2000/01 the subject matter of the coursework was altered so that it could be more closely related to the content of the multimedia tutorials. This close link between assessed coursework and the multimedia tutorials was preserved for the subsequent academic year as well. Student use of the CD based material rose dramatically with almost all students stating in the questionnaire that they had used the CD on an almost weekly basis outside of timetabled classes. Whilst use of the CD increased during the semester, the frequency with which students tried the on-line tests did not however change markedly.

In both 1999/2000 and 2000/2001 an asynchronous discussion board had been made available for students. However in these years use of the discussion boards was very disappointing, with hardly any students using the facility. In the last academic year however (2001/2002) the use of the asynchronous discussion boards available within Blackboard was closely related to the normal coursework exercises and

was also directly assessed. This led to intensive use of the discussion boards by all students.

The FAQ system and, in the last year, the discussion boards were more intensively used whenever a coursework deadline approached. Indeed the major use of the FAQ system was to ask questions related to the subject matter of these exercises. The usage statistics generated by Blackboard in academic year 2001/2002 clearly showed how activity, particularly in the discussion and commu nication areas, rose dramatically a few days prior to submission of a coursework exercise. Equally, it was clear from the statistics generated by Blackboard that by far the greatest amount of time spent by students within the VLE was devoted to the discussion and communication areas.

7. The tutor's view

In the first year of this study, the tutor felt considerable apprehension especially after the first few face to face classroom sessions. This feeling came about mainly as a consequence of the number of worried remarks and comments made by students who had come to the module expecting to be listening to the tutor for most of the class. It became quite clear very quickly that some students disliked the approach much more than others and at times, because of this, it was very tempting for the tutor to slip back into a much more didactic form of teaching.

Of considerable encouragement however was the receipt by the tutor, in the first few weeks of the module during 1998/99, of an appreciable number of e-mail messages from students which tended to suggest that as many as half at least of the class were trying to work through the materials and ask questions prior to timetabled classes. Many of the email questions received were extremely good ones, and the tutor derived considerable satisfaction from this fact. It was noticeable however that the frequency of e-mail messages did fall after the first three or four weeks. When questioned students stated that time pressures generated by coursework on other modules had led to them having less time to look at the on-line materials. This meant that classroom sessions slowly became increasingly tutor led, especially in terms of identifying the major issues for discussion.

In the last three years of this study the students did not give any collective indication of being concerned by the very different approach to delivery. However in every year there were always 1 or 2 students who required more re-assurance than others and even in 2001/2002 there were still some who were worried because of their limited experience of the use of computers in the learning process.

Introduction of the VLE Blackboard in the final year of this study provided for the first time a capability to track and monitor student access to the materials and communication tools. The tutor reported that the availability of this tracking felt like a big advantage. Unlike in previous years, where by and large he had to hope that students were actually making

use of the materials and tools outside classes, it was possible to check whether they were, at least to a degree. This had some immediate benefits. One was that early in the semester it was possible to identify students who by virtue of their limited virtual presence, might be struggling with the subject matter or experiencing personal problems. This monitoring led to the tutor sending an e-mail to 4 students, two of whom responded immediately and came to talk to the tutor about their respective situations. Another advantage felt by the tutor was that it was possible, by including measures of virtual attendance, to report for the first time in many years almost 100% student involvement in the module on a weekly basis.

8. Overall student performance

Almost all students who were interviewed in the evaluation process stated that they did not think the approach to module delivery would significantly affect their performance in comparison with other modules that were being delivered in a more traditional fashion. There was however a general view that the availability of the on-line module resources would help them when it was time to revise for the exam.

Over the four-year period a total of 131 students took the module. Out of this total 7 failed the module. The average examination mark achieved over the four-year period was 51%.

Both the failure rate and average examination mark compare well with those found for other modules taken by the same students at the same time. In addition the figures are comparable to those found on similar undergraduate courses at other UK universities. If anything the average written examination mark is higher than is often found on UK undergraduate courses.

9. Discussion and conclusions

It seems clear from this study that it is possible to dispense with most formal lecturing and replace this with other means of delivering information to students (e.g. web pages, audio/slide presentations). Indeed others have previously demonstrated the feasibility of doing this (e.g. Matthew 1994) The time saved by not lecturing can be used for other more interactive activities, such as the provision of feedback to students.

Eventually, most students did not seem unduly perturbed by the lack of emphasis on lecturing. Equally most of the students involved in this study were very positive about the use of technology. What they were not entirely positive about was a shift in emphasis from didactic methods and 'black or white answer' coursework assignments. Some students seemed genuinely intimidated by the individual attention they received in classes. However there were enough comments through the evaluations to show that a majority welcomed the greater freedom and responsibility they had during classroom sessions. It is of course possible that some of the 'positiveness' shown by students was directly due to the

technology in its own right. Others have previously reported that the very use of ICT in a traditional university environment can stimulate student interest merely because of the novelty aspect of its use (Kulik and Kulik 1991).

Understandably the major focus for all students was to pass their course and this desire was strongly manifested in their behaviour. The basic rule seemed to be 'if it isn't assessed leave it alone'. Such a focus is perhaps hardly surprising. After all, in the busy World of the 21st Century how many of us have the luxury of time to do something extra, unless of course we are exceptionally passionate about the subject matter or about learning in general. An assessment focus has been reported before by others for more conventionally delivered courses (Carpenter 1975; Chansaker and Roundtray 1980).

Students on the module gave every impression, during discussions in class and at feedback, of feeling totally swamped with information and coursework at university. In that sense they saw this module as a form of 'light relief', not because the module was perceived to be any easier but because it facilitated the collection by students of learning resources. Indeed many students commented that if anything the coursework on this module was harder than that on other modules, citing particularly the fact that coursework exercises were too 'open ended'.

Overall the outcomes from this work could be presented most favourably. Students spent more time in classes working independently and actively, relating what they did to the information and insight provided to them through the module learning resources and overview presentations. Many students professed to seeing the advantages to them of such an approach. However, it might be unwise to readily extrapolate the findings of this work to other subject disciplines or even other topics within the Biosciences. The highly context dependent nature of learning has been previously pointed out as a reason to be very cautious about positive reports of ICT use (e.g. Healey 1998). Nonetheless, positive reports continue to grow in number and it begins to become clear that most learning contexts can find benefit from the judicious use of ICT to deliver information and/or promote communication.

There have been many 'uncomfortable' changes in higher education in the UK over the past 10 – 15 years. Both students and staff, have been affected by the increases in class size, diversity and costs. Undoubtedly staff now have less time to provide individual or even small group help to students and increasingly students are associating university learning with lectures (Lammers and Murphy 2002). Perhaps as a consequence of this, more and more students are failing to even begin to grasp the fundamentals of independent and critical thought and there are signs of a slide towards increased success for rote learners.

In conclusion it seems undeniable that using ICT can provide information so that classroom sessions can be used

differently. Equally the on-line communication possibilities that ICT affords provides further ways to stimulate the student activity that is so sought by teachers and employers alike. The <u>precise</u> way in which ICT is used and can benefit will probably always be context specific to a degree. However the fundamental capability of ICT to deliver information and organise communication outside of the classroom is generic and should therefore be applicable in some way across all subjects and circumstances. ICT presents itself as an opportunity to begin reversing the unfortunate trend towards a 'unidirectional' model of higher education brought about largely by increases in student numbers and a decline in the unit of resource.

It is not clear whether approaches such as the one described in this paper will lead to higher levels of achievement by students. What is clear though is that using ICT can lead to a more enjoyable and fulfilling experience for both students and staff in the 21st Century. A deeper goal should of course be the attainment by students of higher level skills. This may eventually come as more and more staff experiment with the opportunities that ICT offers and assessment regimes change to reflect higher level thought. For the immediate future though we should perhaps simply accept the enjoyment factor which using ICT can bring to potentially monotonous and depressing higher education experiences.

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