Effective Use of IT: Guidance on Practice in the Biosciences

Lorraine Stefani

Teaching Bioscience: Enhancing Learning Series

Edited by Stephen Maw and Jackie Wilson
Effective Use of IT: Guidance on Practice in the Biosciences

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Teaching Bioscience Enhancing Learning is a series of guides intended to be an accessible introduction to good learning and teaching practice within the context of competing research and institutional pressures. The aim of each publication is to provide a persuasive overview of the pedagogic reasons for adopting a particular practice and support these reasons with sufficient practical guidance and information to turn ideas into reality. The guides are structured around a common format; Chapter 1 provides a general introduction to the topic, Chapter 2 advice on how to implement the topic and Chapter 3 more in-depth information on the topic and the opportunity to investigate it further. In addition, each guide contains a collection of bioscience case studies highlighting how others have introduced the topic into their teaching practice. It is intended that the guides will be useful to academics in their first year of lecturing, particularly those who are studying for Postgraduate Certificates in Learning and Teaching in Higher Education, as well as to those with many years of teaching experience.

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Introduction

The purpose of this Guide is two-fold: firstly it is intended to provide useful insights into current thinking about pedagogically sound uses of IT in teaching, learning and assessment, and secondly to showcase examples of how technology is being used in a variety of ways within bioscience subject areas.

Chapter 1 explores some of the key issues associated with the use of technology in teaching and learning and describes many of the computer applications commonly used in everyday practice. This chapter also examines knowledge and understanding of traditional, classroom-based teaching and assessment practices, the underlying pedagogical principles, and their transferability to e-learning.

Chapter 2 takes an in depth look at curriculum design for e-learning with examples drawn specifically from the biosciences. The intention of this chapter is to enthuse readers who wish to enhance their use of IT in teaching and also to provide some research findings on how students respond to learning in an online environment.

Chapter 3 considers the potential for computer-based assessment strategies, again drawing on examples from subjects within the biosciences. This chapter also highlights some of the key principles of assessment that relate both to traditional and online assessment strategies.

Bioscience Case Studies: the second part of the Guide provides six case studies of e-learning in the biosciences covering a wide range of topics and subject areas such as: using online databases and predictive modelling to answer questions about global population and food requirements; Really Simple Syndication (RSS) – using the Internet in innovative ways to enable students to access, evaluate and use information; and computer-based assessment to set the pace of learning.

All of the case studies show innovations that are transferable to other subject areas. Each is written with enthusiasm and passion and gives insight into the problems or issues associated with implementation as well as the successes. Together the individual case studies encompass the theoretical concepts covered in the earlier chapters. Expanded versions of the case studies, video clips, further bioscience case studies and supporting material are available from the accompanying web site to this guide (http://www.bioscience.heacademy.ac.uk/TeachingGuides/)
Chapter 1
Exploring the use of technology in teaching and learning
What do we understand by e-learning?

The question, ‘what do we understand by e-learning?’ is problematic to answer. In recent years the term ‘e-learning’ seems to have become shorthand for almost any teaching and learning activity involving educational technologies. This catch-all term for the use of technology in teaching may, on the one hand, be perfectly acceptable. On the other hand, there is a danger that this casual approach can mask the need for the underlying philosophical and pedagogical principles of student learning to be interrogated and addressed if e-learning is to live up to the buzz words often associated with the concept. These buzz words include: flexibility, independent learning, distance learning, student-centred learning, life-long learning, virtual classrooms, virtual laboratories and blended learning (Steel and Hudson, 2001).

These buzz words are in themselves an indication of the global changes in higher education. There has been a shift to mass higher education, increasing levels of internationalisation, recognition of the impact of diverse student populations and the need to accommodate different learning styles and strategies, and most of all the change of focus from teaching to facilitation of student learning (Stefani and Nicol, 1997). In this changed and changing context there is a growing need and enthusiasm for the potential of technology to support student learning.

The potential of technology to support teaching and learning in any subject area does, however, create some tensions. Educationalists see computer technologies as essential tools of the teaching trade (Sandholtz et al., 1997) that, when used appropriately should have a positive impact on the student learning experience (Berman, 1998). Educational managers either do not fully appreciate the complexities of changing the nature of teaching and learning to fully exploit the potential of technology or they see technology from the viewpoint of efficiency gains. To get the very best out of the potential of computer technologies, university managers need to recognise the importance of: technological infrastructure to the success of the venture; the need for increased blurring of the boundaries between the roles and responsibilities of academic and academic-related staff and the need for strong partnership arrangements between academic staff within their disciplines and staff in central service units. Many academic staff find the idea of changing their conceptions of teaching
problematic and time consuming and there can be issues relating to development of the necessary skills to manage teaching and learning mediated by technology. High levels of investment in appropriate professional development are essential to the effective and efficient use of technology in teaching and learning.

Using technologies in teaching provides no guarantee that the student learning experience will be enhanced because technology in itself is not the panacea to all teaching and student-learning problems and issues. Whatever the medium used for the purposes of facilitating student learning, first and foremost must be a fundamental understanding of teaching, learning, assessment, curriculum development and design of learning tasks. However, for e-learning to live up to the buzz words mentioned previously it must be fully appreciated by all that the use of technology in teaching needs be underpinned by sound pedagogical principles.

Applications

Many academic staff initially feel fearful of technology and of adapting their teaching styles and strategies to accommodate technology and e-learning inputs. There are three possible reasons for this. Firstly, academic staff are hard pressed to cope with the multiple facets of their roles and responsibilities and learning the intricacies of technology can be seen as another burden on already busy people. Secondly, there is the anomalous situation whereby technological advances are always ahead of our capacity to transform our teaching and learning strategies (Steel and Hudson, 2001). It can seem a never-ending battle just to keep up with the technology, never mind the pedagogy. Thirdly, there is evidence to inform us that there is still a lot of content-driven, transmission-mode teaching occurring (e.g. Badge et al., 2005). To shift the emphasis from teacher-centred, transmission-mode to student-centred, inquiry-based learning demands greater levels of understanding regarding student learning, curriculum development and learning design.

Focusing on common uses of technology one can see that most people probably have a wider range of technological expertise than they give themselves credit for. Combining these skills with greater levels of reflection on student learning and existing expertise goes a long way to achieve a transformative model of teaching. (For further details on transformative learning see Cranton, 1994). Some common uses of technology in teaching and learning are outlined here:

**Everyday use of e-mail**

It is highly unusual to come across university staff members who do not use e-mail. Almost everyone uses it on a daily basis as a means of communication. Most students have access to computers and e-mail accounts. E-mail can therefore be used as a means of communicating with students. The better the institutional infrastructure, the more use can be made of e-mail. Students can be asked to send in assignments as e-mail attachments and can receive feedback on assignments by e-mail. This simple usage of technology is applicable in any subject area including the biosciences.

**Using the World Wide Web**

Most academic staff will use the Web at some point for finding interesting materials and resources and most students are familiar with ‘surfing the Web’. ‘Surfing the Web’ can be integrated into any course as part of developing students’ information literacy skills for example. While academics worry a great deal about plagiarism and students’ abilities to copy material from the Web, it is more productive to invite students to find materials from web sites and to analyse these resources (Stefani and Carroll, 2001), than to worry that students will plagiarise material found on the Web and put more and more resources into detecting plagiarism. Changing the nature of the curriculum to include students’ skills levels in information retrieval, analysis and evaluation can alleviate the plagiarism problem (Carroll, 2002; Stefani and Alsop, 2005).

**Use of software packages such as PowerPoint**

The use of PowerPoint is almost overdone in teaching and learning. In many subject areas it is unusual for students to be subjected to anything other than PowerPoint presentations. However, to have used PowerPoint is to have used technology in teaching. While there are disadvantages to PowerPoint, which are no different to the mis-use of overhead transparencies e.g. font size too small, too much text per slide and so on, there are also advantages to be exploited. PowerPoint slides are easily changed for use in different contexts.
represent ‘convenient’ uses of technology. However, to properly consider the redesign of courses towards a more technology-mediated format, and embed e-learning as an integral aspect of the curriculum, there is a requirement to think through the pedagogical principles underlying student approaches to learning. The next section will explore these issues in more detail.

The shifting role of the university teacher

While there can be no doubt that major advances have been made in the past few years regarding the conceptions of teaching and our understanding of student learning, much of what has been learnt is yet to be transferred successfully into the context of e-learning. For example, just a few years ago Littlejohn and Stefani (1999) reported on a survey that indicated many academics view the Web as another means by which they can deliver their lecture notes. There is still some anecdotal evidence to suggest that this view prevails amongst some academics. However, this appears to be due mainly to the fundamental misconception that the use of new technologies involves simply transferring traditional teaching methods into an electronic format, with little attention being paid to the underlying pedagogical implications (Littlejohn, 2000). As the case studies in the second part of this Guide will show, there are now excellent examples of pedagogically sound uses of technology in teaching in the biosciences.

The worst of e-learning courses are nothing more than endless text on rolling screens. This model of e-learning signifies that those responsible for designing the course had little understanding of how students learn in a technological environment. Rather, they have transferred a teacher-centred, content-driven curriculum from their filing cabinet to a computer. While simple transference of material used in more traditional, classroom-based teaching contexts on to a web site or into a VLE may be convenient for teachers and lecturers, for the students, it means downloading and printing off text. This does not enhance student learning and in fact can reinforce a conception of learning premised on the need for a good set of notes to be regurgitated for the purposes of assessment.

If no one asks simple questions such as ‘What is the impact of my teaching on student learning?’ (within a classroom context) how can technology be expected to magically solve all the problems or

Use of a Virtual Learning Environment (VLE)

Many universities will have a VLE, the most common of which are Blackboard and WebCT. While a VLE is hugely beneficial to universities as an administrative aid for posting student exam results and maintaining student records, a VLE can also be used to support teaching and learning. Lecture notes and PowerPoint presentations for a particular course can be posted on to the VLE for easy retrieval by students. This can be helpful for students who were unable to attend a lecture for example, or if the PowerPoint presentations and lecture notes can be posted onto Blackboard, WebCT or any other VLE being used, this gives an opportunity to stress to students that they do not need to spend time writing notes, but can focus on listening and responding to questions. Good use of a VLE can go some way to transforming what is actually happening in the classroom. A VLE can be used in other ways too, it can be used to encourage greater levels of peer learning. This aspect of a VLE will be explored further in Chapter 2 of this Guide.

Use of interactive CD-ROMs

There are many commercially available interactive CD-ROMs applicable to the biosciences. Obviously, making choices about what resources are suitable for use with students is dependent upon the intended learning outcomes for any course. For simulations of laboratory experiments for example, it may be considered more important to develop your own CD-ROMs in conjunction with the multimedia unit within your university. What is important in using this type of resource is how it is used and how the simulation package is integrated with other teaching materials.

The above examples of common uses of technology in teaching do not, in themselves, involve major changes in course perception and curriculum design nor do they fundamentally shift thinking with respect to facilitating student learning. Rather they

and they can very easily be made available to all students if a Virtual Learning System such as Blackboard or WebCT is in common usage within the wider university.
perceived problems regarding student motivation and engagement? The integration of e-learning or flexible learning using technology is likely to be influenced by current conceptions of teaching and it is this aspect of work that needs to be reconceptualised.

Whatever the context of learning, be it traditional, classroom-based; distance learning; or e-learning, the purpose of the course or programme, the design, development and mode of delivery and associated assessment strategies must be carefully considered. To successfully design any course, the following elements are essential components to interrogate:

- **Background or context.** For example, department, faculty, institution, student group and teacher.
- **Intended learning outcomes.** What the students are able to do at the end of the course, expressed in active verbs. Learning outcomes must be specific and measurable.
- **Assessment of student learning.** What will be assessed? How will you assess for the learning outcomes? Assessment should encompass both formative and summative elements. The criteria should be clear to the students and they should be explicitly linked to the learning outcomes. In many situations students should be involved in assessment strategies, for example, in negotiating assessment criteria for self- and peer-assessment activities.
- **Content.** Course content should be selected to support the learning outcomes and the assessment, standards must be articulated, and course content should encompass knowledge, skills and understanding.
- **Course Structure.** The teaching and learning strategies should be planned, e.g. lectures, practical classes, tutorials, self-directed learning. Appropriate choices should be made taking into consideration students’ different learning strategies.
- **Classroom.** The learning outcomes can be specified for each learning session and the most appropriate format for learning considered. Is it a traditional, classroom-based session or is it a virtual session?
- **Evaluation.** Plan for how the course quality will be evaluated; include multiple sources of evidence.

*(Henderson, 2005 - personal communication)*

This outline for course design was presented by an academic staff member participating in a postgraduate certificate programme relating to learning and teaching in higher education. The participant teaches on courses encompassing a high level of e-learning.

**The relationship between teaching beliefs and successful adoption of new technologies**

In the past it has not been uncommon for curriculum development to occur in the absence of any guiding model or framework. There has been a tendency for courses to be designed from the starting point of content, followed by how this content will be delivered, as in by means of lectures, tutorials or practical classes, with the addition of activities such as group projects. Assessment of student learning has largely focused on knowledge and assessment is often ‘bolted’ on at the end of the line. There are curriculum development frameworks which can help shift conceptions of teaching and learning. One such model is a modification of that presented by Cowan and Harding (1986), shown in Figure 1. This logical model of curriculum development has been shown to be a successful tool in many different disciplines including subject areas within the biosciences (Stefani, 2004). The model shown, places the intended learning outcomes as central to all aspects of course design. If the learning outcomes have not been considered, how can the assessment strategies be aligned? Defining the intended learning outcomes clearly and in accessible language can support students in thinking through their own learning strategies as well as enabling teachers to consider how they will facilitate student learning to achieve the intended outcomes. The model is deceptively simple in that it is premised on three questions relevant to each stage in the cycle.

*Figure 1. A logical model of curriculum development*

*(Cowan and Harding, 1998; Stefani, 2004)*
To answer this question requires an analysis of key features of e-learning. As with traditional, classroom-based learning, e-learning (as instruction using technology) should encompass the following attributes:

- Consideration of the intended learning outcomes for any programme, course or module;
- A strategy for assessing for the learning outcomes;
- Consideration of instructional methods which will engage the learners. In an e-learning context, it is essential that students are not faced with vast quantities of course content on screen. Inclusion of examples of ‘concepts in action’, applications of concepts and practice elements with feedback to support learning are key to engaging the learner;
- Media elements such as text, diagrams, pictures, and video streams to deliver both the content and the learning methods; and
- The potential to construct new knowledge and skills aligned with the learning goals.

(adapted from Clark and Mayer, 2002)

The basic premise of effective e-learning course design is not dissimilar to effective course design for non e-learning courses. However, what becomes more obvious in curriculum design involving e-learning is that in moving to a new model of delivery, more emphasis on learning design is required than is taken for granted in classroom modes of delivery. The significance of learning design will be the focus of Chapter 2 of this Guide.

Well designed e-learning programmes present an excellent opportunity to encourage the shift from teacher-centred, content-driven courses to student-centred, enquiry-based courses with the potential to motivate and engage the learners. However, before rushing to design e-learning courses, it is important to ask ‘Why e-learning?’

An important question to ask is: ‘Will the models outlined above be helpful in the context of e-learning?’

For example, linking assessment to the intended learning outcomes raises the following questions:

- How will the intended learning outcomes be assessed? The learning outcomes should incorporate, knowledge, skills and understanding;
- What will be assessed? To move away from an excessive focus on course content the answer to this question should include both the product and the processes of student learning; and
- After consideration of ‘how?’ and ‘what?’, as a point of reflection, ‘why have those choices been made?’

These same simple questions can be asked all the way round the model (Stefani, 2004; Cowan and Harding, 1986) and they encourage consideration of the curriculum in broader terms. What is interesting to note about this model is that assessment is considered once the learning outcomes have been determined, rather than at the end of the cycle. This is why the model was termed a ‘logical model’ because it differs significantly from a chronological model where the stages are: learning outcomes (or aims and objectives): course content: teaching and finally assessment. A second model of course (or curriculum) design presented by Biggs (1999) is premised on his theory of aligning teaching, learning and assessment (see Figure 2). Research on student learning indicates that for any course students tend to think about assessment first rather than, as their lecturers or tutors often do, as the last piece of course (or curriculum development) that needs to be considered. Both of the models move away from a chronological view of teaching and learning. The stage by stage process of curriculum design outlined above by Henderson (2005) is another way of representing or conceptualising Cowan and Harding’s model.

Figure 2. Biggs’ model of alignment of teaching, learning and assessment

Teacher perspective: assessment

Student perspective: outcomes

Teaching activities

Learning activities

Teacher objectives

Student assessment

(Biggs, 1999)

An important question to ask is: ‘Will the models outlined above be helpful in the context of e-learning?’

Supplementing and complementing classroom-based or face-to-face teaching? For example, a blended learning strategy where courses consist of a mix of face-to-face and technology use.

Flexibility and accessibility? Taking into consideration the varied responsibilities of
practice and this is hugely positive. Which model or models gain favour with academic and or educational developers supporting academic staff often depend upon the culture of the institution, the particular leanings of educational developers and the intended learning outcomes for particular groups or populations of students. However, according to Beetham et al. (2001) there is, as yet, little evidence that these models are being applied to the development of e-learning courses and programmes. For example, internet searches, word-processing and multimedia presentations are increasingly common practices in many subject areas but it is not clear that the integrated use of computers for promoting critical thinking processes and as a focus for communicative interaction is very common (Loveless et al., 2001).

Conole et al. (2004) have suggested that this may be because many e-learning practitioners find the diverse array of theoretical perspectives alien and overwhelming. Another possible explanation is that academic staff working in partnership with educational developers specialising in e-learning are not necessarily re-conceptualising the curriculum for a different mode of facilitating student learning. Many experts in the field of computer-mediated or technology-mediated learning advocate engaged peer interactions with a shared computer activity. As stated by Kimber and colleagues (Kimber et al., 2005), this socio-cognitive view of education recognises the interdependency of communicative interaction, new technologies, the design of computer-based tasks and focussed activity for learners to become critical thinkers and creators of knowledge.

The skills of academic staff in designing learning activities that effectively apply collaborative inquiry to electronic tasks for deepening student knowledge remains crucial whatever the subject area, student age or software choices (Kimber et al., 2005).

Models of student learning based on an underpinning body of research

Numerous models for learning have been proposed within the literature which are easily accessible to academic staff and often suggested as primary reading in accredited postgraduate professional development programmes for new staff. Examples of such models include Kolb’s experiential learning cycle (Kolb, 1984), Jarvis’ model of reflection and learning (Jarvis, 1987), Laurillard’s conversational framework (Laurillard, 2002) and Barnett’s framework for higher education (Barnett, 1990). While it is not appropriate in this Guide to give full explanations of the similarities and differences between these theoretical perspectives on learning, all of the literature referenced is easily accessible. All of the recent literature on teaching and student learning indicates that students learn best if they are encouraged to become actively involved in the learning process. Courses based on vast quantities of content are known to lead to passive learning and most likely regurgitation of that content in assessment tasks (e.g. Ramsden, 2003; Prosser and Trigwell, 1999; Biggs, 1999). This is not to argue for courses without content, but course or curriculum content should never be the main aim.

There is growing evidence to suggest that more academic staff are interested in engaging with and applying learning models within their own classroom...
topics and from body language they can sense levels of engagement or understanding. These social cues are generally absent in computer-mediated teaching and learning.

There are 3 key factors to be considered with respect to changing the medium of learning. Firstly, there is the issue of the mediational role of the computer (Bliss and Säljö, 1999), as well as the communicative and intellectual dimension of collaboration (Mercer, 1995). For computer-mediated learning to be successful, it is important to acknowledge the social dimension of learning. Merely asking students to sit down and interact with a computer, as in seeing only the computational use of new technologies, will not in any way enhance learning. Secondly, it is becoming more and more clear that ad hoc approaches to curriculum design, development and delivery will not necessarily adapt easily to the concept of e-learning. Why is this the case? It is the case because there is still more focus on course content at the expense of student learning and a reluctance towards the ultimate purpose of higher education – the transformation of knowledge and creativity in knowledge generation. Effective e-learning encompasses the potential for students to construct electronic representations of their knowledge as a way of deepening and communicating their understandings and for enhancing learners’ critical thinking skills (Kimber et al., 2005).

The third point is that academic staff need to recognise a new skill set in course design and be prepared to reflect on and acknowledge their own shortcomings in technoliteracy. For the time-being, many individuals may prefer to rely on e-learning experts to help them through the transformative change but in due course, the widespread use and potential of technology will dictate that all staff embrace e-learning design.

Summary

In summary e-learning is not a panacea for all of the issues faced in the modern university. To live up to the goals of higher education in terms of developing independent learners, critical thinkers and creative, knowledgeable graduates there is a responsibility to consider the overall learning experiences of all students. Embedding e-learning into the student learning experience means academics must interrogate their own approaches to curriculum design, the development of learning activities and student assessment. This chapter has attempted to highlight and explore many of these issues. The next chapter will focus on current e-learning applications across different subject areas in the biosciences.
Chapter 2

A focus on e-learning in the biosciences
Introduction

The focus of this chapter is to examine the importance of learning design to the effective and successful integration of e-learning into the curriculum with a particular emphasis on e-learning applications within the biosciences.

It is important to re-iterate that a model of e-learning integration which is anchored to the perceived need for student acquisition of marketable skills for the ‘Information Age’ does not capitalise on the potential of electronic cognitive tools to enhance the learning process or to facilitate students’ critical engagement with subject content (Kimber et al., 2005). The focus for designing e-learning components of courses must be recognition of both the cognitive and the social dimensions of learning rather than the application of isolated technological skills.

If e-learning is to be successfully integrated into the overall teaching and learning strategy for any course or programme of study, there is no escape for lecturers/tutors regarding the need to understand key aspects of student learning and learning design. Integrated technology use in a course or programme should be synonymous with the concept of ‘learning with technology’.

Curriculum design for e-learning

Curriculum design for e-learning is often called Instructional Design. This is an American term gaining wider currency in discussions about e-learning. The term Instructional Design is defined as: the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction. This terminology is rather clumsy. In essence the pedagogical principles of teaching and supporting student learning must be applied to the design and development of online or web-based modules, courses and programmes of study. Instructional Design is a useful term because it encompasses the entire process of analysis of learning needs and goals, and the development of a delivery system to meet those needs. It includes the development of learning materials, activities, practice elements (often using technology) and evaluation of all teaching and learning activities (Clark and Mayer, 2002).

In simpler terms Instructional Design means linking learner analysis to the design and development of resources. The term is introduced in this Guide because of its prevalence in much of the current research literature on e-learning.

It is worth noting that development of e-learning course components may initially, in the developmental phase, be seen as more complex than designing a course for traditional, classroom-based delivery. However, there are two key issues to be considered with respect to this potential complexity. Firstly, there is still ample anecdotal and published evidence (Stefani 2004) stating that despite the rhetoric and the language used in most universities relating to teaching and learning such as: active learning, student-centred learning, flexible learning and student diversity, students are still exposed to a content-driven, transmission-mode of teaching, particularly in large classes. Academic teaching staff do not necessarily interrogate the above terms and modify their course design or their teaching methods in accordance with the meaning of these terms.

A further point to note is that Instructional Design and all it encompasses in the context of e-learning, is much more likely to be productive if academic staff working in their disciplines can work in partnership with staff from a unit such as a Centre for Educational Multimedia. Although it is sometimes the case that lone champions of e-learning carry good work forward.

Such partnerships make it all the more important that student learning characteristics are taken into consideration when designing online or e-learning courses.

On the social and cognitive aspects of student learning, while a transmission mode of teaching is not ideal and is known to encourage passive as opposed to active learning (Ramsden, 2003) the lecturer can, nevertheless, gain subtle feedback very easily on what is going on in his/her class.

For example, lecturers in the traditional classroom can rely on subtle visual cues from their students. A quick glance across the lecture theatre reveals who is taking notes, who has tuned out, who might be prepared to ask a question or make a comment. Skilful teachers, even in delivery and transmission mode, can respond to the cues and adjust delivery accordingly. Students too can pick up on how their peers are behaving or responding in the classroom.

With e-learning, there are no such visual cues, therefore the instructional design must be explicit in the selection, sequencing and creation of learning experiences. Creative abilities and an underpinning knowledge and understanding of student learning are essential skills for the design of engaging and effective e-courses (Cantoni et al., 2004).
Linking learner analysis to e-learning design

Most learning theories show that interaction and learner motivation play an important role in the teaching and learning process. In an e-learning context what makes the difference is not the technology itself but rather the learning methods enabled and supported by the technology.

A brief foray into cognitive learning theory may help the reader conceptualise the key factors to be taken into consideration when designing e-courses for effective learning:

- Human memory has two channels for processing information: visual and auditory;
- Human memory has a limited capacity for processing information;
- Learning occurs by active processing in the memory system; and
- Extra knowledge and skills must be retrieved from long term memory for transfer to the task in hand.

(Clark and Mayer, 2002)

In simple terms, the way information is laid out can have a significant effect on the ease with which readers engage with the content and the effort they need to make to extract deeper meaning from the information presented. Well designed e-learning courses taking into consideration issues such as anytime, anyplace learning, are easy to navigate, include self-assessment tasks and are an integral part of an overall course or programme. Student learning should be an active rather than passive endeavour but to achieve this, students need to be aware of their responsibilities and be introduced at an early stage to the expected learning outcomes. There is a tendency to take it for granted that students understand their responsibilities for their own learning. If a substantial change is made in the medium then this should be accompanied by an appropriate student induction into the new context.

Examples of e-learning applications in the biosciences

i) The web page versus the Virtual Lecture

An excellent example of good versus bad e-learning design from within the biosciences comes from Chris Evans from the Department of Biological Sciences and his colleagues from the Centre for Multimedia at Brunel University.

In designing e-learning modules in the subject areas of genetics and reproduction, Evans et al., (2004) tested a hypothesis that material presented in an interactive, easily navigable, computer-based learning system which they called a ‘Virtual Lecture’ creates a significant improvement in the student learning experience over identical material presented simply as pictures and text in scrollable web pages.

In the first instance of the move to computer-based learning, in this example, subject content was transferred onto a web page. This web page material had quite simply been constituted from expanded lecture notes translated into hypertext mark-up language (HTML), formatted into readable text, with picture images added in. Internal hyperlinks were used to take the learner to other pages in the site. The overall emphasis for this type of online delivery was to ensure content coverage, rather than thinking through the issues of how students learn and designing the course accordingly. From a learner perspective the web page mode of delivery seemed little different from being asked to read the relevant chapter(s) in a textbook. Unsurprisingly, most students simply printed off the web pages because this was easier than reading through the large volumes of text on-screen. Student evaluation and feedback on this mode of learning, perhaps unsurprisingly, showed it to be very unpopular.

In contrast to this the development of the Virtual Lecture took into consideration the principles of instructional design and the knowledge and understanding of student learning. The Virtual Lecture consisted of material embedded in a specially designed multimedia shell implemented in Macromedia Authorware (a commercially available software package). Principles of good course design were used with a particular emphasis on usability and interactivity. The course material was well structured into key topics and sub-topics, navigation bars were included to enable students to move easily through the materials and both internal and external hyperlinks were included to enable students to access or browse additional materials. The Virtual Lecture was constructed carefully to be highly interactive with audio and visual feedback components and interactive self-assessment questions (full details of the design principles used are given in Evans and Edwards, 1999).

Different cohorts of students experienced these online modules which varied widely in their design...
principles. A careful study was carried out to compare achievement levels and the authors presented strong evidence to indicate that online presentation in a structured, navigable, interactive learning environment significantly improved the students’ learning experience.

The authors concluded from their endeavours to improve classroom teaching and to embed e-learning or online learning into their courses that: “while web pages offer all the advantages of open and distance learning, such as flexibility of pace, time, location for learning and empowerment of students to take control of their own learning, these advantages are not in themselves sufficient to improve learning. Rather, the online learning environment needs to be underpinned by sound pedagogical principles” (Evans et al., 2004).

Relating some of the Instructional Design points mentioned above to the example of the ‘web-page’ versus the Virtual Lecture approach to e-courses on genetics and reproduction: the Virtual Lecture encompassed both audio and visual feedback components, the ‘notes on the web’ approach confronted the learner with rolling text, too much for students to accommodate without printing off all the material; the Virtual Lecture included interactive self-assessment questions, thus motivating the learners, stimulating learning and affirming learning through the self-paced assessments in-built into the programme.

Any e-learning course should be constructed in light of how students learn and on the basis of experimental evidence concerning e-learning features that promote best learning. An error in judgement that is often made is that decisions about how to design e-learning courses are based on the capabilities of the technology. This is a technology-centred approach to Instructional Design rather than a learner-centred approach. The example described above highlights the comparison between a teacher-centred, content-driven approach to instructional design versus a student-centred, inquiry-based learning approach.

ii) Laboratory simulation experiments

Simulations of laboratory experiments are an interesting issue. In many bioscience subjects, lecturers are faced with extremely large classes. Not only is it expensive to run laboratory-based, hands-on practical classes, it is becoming more difficult to ensure positive learning experiences for students. For pragmatic reasons, practical classes cannot be changed and modified on a regular basis and there are limitations in some subject areas regarding the availability of up-to-date equipment. There are also difficulties relating to the composition of the classes. Many students in large science classes will not progress to employment involving laboratory work. Some students are enrolled in courses that are prerequisites for progression to further study but they are not necessarily excited by these courses. Simulations of experiments therefore seem a good idea. Many simulations of experiments actually allow students to develop a range of key skills such as data handling, interpretation, communication and experimental design. These are all skills valued by employers (Knight and Yorke, 2003) and in some instances these skills can be highlighted more through simulations than actual practical experiments. This makes it all the more crucial that lecturers and teaching staff keep in mind the intended learning outcomes of any course and affirm these skills when working with their students.

Ian Hughes (Hughes, 2001 and 2002) from the School of Biomedical Sciences at the University of Leeds describes two different types of laboratory simulations. The first is whereby the programme designer has developed a set of experiments with a prescribed sequence of events to be presented to the students, more of a visual aid than a hands-on learning experience. A second type of simulation allows the user/learner to determine the sequence of events and allows for analysis of data produced by the learner. For example, in the context of pharmacology this would involve students thinking through the purpose of the experiment or the experimental parameters and being able to manipulate the choice, dose and timing of drug administration. This second type of simulation is enormously flexible and allows for the design of complex and sophisticated experiments.

Hughes, however, reports on an example of students using a simulation of a practical experiment rather than a ‘wet lab’ class. When the package was used in conjunction with tutorial/discussion sessions student satisfaction based on issues such as ease of use and navigation, appropriateness and level of content, clarity of explanation and usefulness as a learning aid was very high. The students using simulation also scored highly in an MCQ test on the material in the package. The key issue here was that the simulation of the experiment was integrated with other teaching material as part of the course (Hughes, 2001; Hughes, 2002). In an interactive, laboratory simulation situation students can take risks and make mistakes without directly exposing themselves in front of peers and tutors or lecturers.
Hughes gives an excellent summary of the essential requisites of teaching packages delivered through the medium of technology. They are as follows:

- Accessibility and ease of use are of paramount importance;
- Reliability of IT infrastructure is essential;
- Computer packages/online teaching resources must be fully integrated into courses and their purpose must be made explicit to the students. The overall purpose should be in accordance with intended learning outcomes and include the development of essential skills as well as knowledge, information and understanding;
- Assessment of student learning must include the successful achievement of the learning objectives and learning outcomes of the course;
- It is essential to highlight and explain the key skills which can be developed using computer packages/learning resources;
- Students need to understand how to use the material, what depth of knowledge is required, and how computer aided learning complements learning in other formats; and
- The role of the lecturers/tutors is to facilitate the student learning with the aid of resources such as computer packages, not to abandon the students to their own devices.

(Adapted from Hughes, 2002)

Many simulation packages are now available commercially and choices need to be based on intended learning outcomes of a course, relevance of the package and potential to integrate with other aspects of course content, assessment and modes of teaching and learning.

iii) The hybrid course

Following on from the idea of using computer simulations of laboratory experiments for large classes, Riffell and Sibley (2005) from Michigan State University report on a hybrid course format which incorporates web-based instruction to enhance learning in large undergraduate biology courses. The format of their high-enrolment, introductory environmental biology course was part online and part face-to-face.

The nature of this course was radically different from their traditional type of course whereby students were expected to attend a large number of lectures per week. Observations of the classes showed problems that are all too familiar: poor attendance, low attention levels and poor performance by many students.

The change in format to a hybrid course was such that only once per week did students have to attend lectures. However, the design of the lectures was changed from transmission and delivery of content to interactive, problem-solving sessions interspersed with short bursts of content delivery. Students were encouraged to talk to their peers, as in engage in peer learning in class. In addition to attending once per week, students had to complete bi-weekly, web-based homework problem sets. Each week of the course began with one online assignment due to be sent to the tutor the night before the ‘active lecture’, and a second online assignment which extended knowledge of concepts covered in class was due at the end of the week (Riffell and Sibley, 2005).

The architects of this hybrid course (Riffell and Sibley, 2005) reported: better attendance at the ‘active-lecture’; enhanced peer-learning – as many students communicated with each other over course content; and overall enhanced learning – as related to achievement in end of course assessments.

This hybrid course seemed like an ideal situation for staff and for students. Students had more flexibility and control over their overall learning, and were more actively engaged and actively involved. Well designed web-based courses can be much more student-centred than traditional, transmission-based lectures whereby students believe learning is limited to taking notes. Web-based courses can encourage students to learn in different ways (Calverley, 2003).

In a further re-enforcement of the issue of the importance of a pedagogical underpinning to the success of computer-based learning, Yazon et al., (2002) from the University of British Columbia stated that there is a clear need for educators to critically investigate how Information Communications Technology (ICT) can be used more effectively to improve teaching and enhance learning. An essential part of that investigation involved training teachers and the students on the pedagogical perspectives and their respective roles and responsibilities in courses where technology was extensively used.

Yazon et al., (2002) decided on moving a genetics course – in which a majority of the students in the class remained reluctant to relinquish their reliance
on passive learning approaches – out of the lecture theatre and into the virtual learning environment. They designed a hybrid teaching and learning format incorporating an ‘auto-tutorial’, online version of the course in WebCT. The lecture section of the course was modified to a modular, self-directed, online instructional format, with small group, instruction-led tutorial sessions providing the face-to-face component of the course.

The technology-mediated version of the genetics course provides 12 online modular units with learning activities, problem-solving exercises, advice on learning approaches, and hyperlinks to a range of other web-based learning resources. Students move through the modules after completing inbuilt formative and summative tests. An additional exciting feature of this course is that it incorporates an electronic Bulletin Board for student-initiated ‘conversations’ to occur and a student help desk for individual and small-group tutoring. An important aspect of this strategy is that obviously if students do not have to attend so many lectures, this frees up lecture time and lecture preparation time. This ‘extra’ time can be used to engage with the students either through the Bulletin Board or through e-mail contact. It is, of course, only fair to say that there is front loading of the organisational and curriculum design work required to make all this happen.

Yazon and her team carried out a study with the students who engaged in the hybrid approach to teaching genetics (Yazon et al., 2002). The outcomes of the study should be a salutary lesson to anyone who still believes that lectures are successful in engaging students. Most of the students liked the self-paced nature of the study, the anytime, anywhere flexibility and the more visual approach that the online course offered in comparison to the passive nature of content-driven lectures. Needless to say, some students did prefer the transmission paradigm. These same students had a deeply ingrained view of what learning is about – it is about the ‘expert’ delivering information which the student will learn and regurgitate as and when asked to do so (e.g. in an exam). The message here is that students need to understand that their role in learning is not a passive one. Even students who did not particularly like the new hybrid course recognised that the web-based approach made them think more and reflect more on the key concepts of the subject material.

Also experiencing education in a course that combines online and face-to-face teaching conveyed strong messages to the students about the pedagogical significance of peer interaction. The electronic Bulletin Board was considered to be an essential element of the learning process. The belief of Yazon and colleagues is that the reduced level of teacher or tutor contact encouraged students to view their peers as another learning resource.

The concept of peer learning is certainly not new, but it can be difficult to engage students in this mode of learning if their strong-held belief system is that the responsibility for their learning lies with the teacher. Stahl (1999) identified the peer group as the single most powerful influence in undergraduate education, but students must first of all understand this to be the case. Piaget (1971) believed that co-operation between peers is likely to encourage real exchange of thought and discussion. The important word here being ‘co-operation’! Too often students are led to believe that education is a competitive endeavour, rather than a collaborative process. The work of Yazon and colleagues indicates peer learning can sometimes be more successfully encouraged in an online situation than in the classroom.

The presence of the teaching/teacher in online courses may need to be more clearly defined. The teacher plays a crucial, pedagogical, ‘behind the scenes’ role in the overall design of the learning activities and the administration and implementation of the course. The teacher, is in essence, the facilitator of the learning process even though in an online context they may be perceived to be behind the scene!

The issues discussed above affirm the view that students need to be inducted into and prepared for a different learning paradigm. While this is very much the case for any learning context many students are probably of the view that not all courses should be taught online as this would detract from the other social aspects of learning.

**Discussion**

The e-learning examples cited so far are intended primarily for independent learning. While they do not preclude students learning together, there are other examples of e-learning activities intended to enable and encourage interaction with other e-learners and e-instruction, for example: chat rooms; discussion boards; instant messaging; e-mail and blogs, all offer effective means of peer learning and interaction. Many of these ICT applications can be used for formative and summative assessment of student learning.
The goal of any course of study should be to create powerful, collaborative learning environments where learning is holistic and interactive. Student construction of knowledge is the alternative paradigm to the transfer of knowledge from tutor to student. However, according to Barr and Tagg (1995) staff and students need to make significant conceptual shifts in their view of teaching and learning for this new paradigm to become a reality. Many educationalists believe the combination of thoughtful pedagogical practices and technology can support a constructivist learning perspective (Laurillard, 2002). If we want to discourage students from passively assimilating information, course activities and assessment must provide opportunities for students to enact new and effective approaches to learning (Ramsden, 2003).

However, a note of caution should be added here. Academic staff charged with the overall design of programmes of study must consider carefully when to use technology, how to use it effectively and why technology-mediated learning is appropriate. There is a tension inherent in encompassing e-learning into a course or programme of study. It is quite unlikely, particularly in UK universities, that radical decisions will be made in most institutions to adopt technology as the medium for all learning. In other words, few universities will become cyber-institutions. On the other hand e-learning opportunities for students should not be merely for the purposes of ensuring students have had some e-learning exposure before entering into the employment market.

Integration of e-learning into courses must therefore be done carefully. Decisions as to whether e-learning is intended to supplement traditional forms of teaching or to complement traditional lectures, tutorials etc must be made in accordance with the intended learning outcomes for any programme of study, the learning environment and the learning context. For example, if students are simply made aware that a software package exists and that it can be used for extra study or revision purposes, success is likely to be limited (if success is determined by levels of engagement). The context and method of use are dominant issues in terms of student use and student satisfaction.

Students may feel that if one or two sections of an overall programme of study involve e-learning whereas all other aspects of the course are delivered by traditional means, the e-learning aspects were mere experiments. Given that students seem to enjoy a variety of different learning situations, blended learning is probably the goal most universities will work towards.

The next chapter will explore some aspects of the use of technology in assessment of student learning.
Chapter 3
Assessment of student learning in an e-learning context
Introduction

Assessment is widely considered to be the most influential factor related to how students learn (Brown and Glasner, 1999) and yet it seems to be the aspect of curriculum design and development that causes teachers the most difficulties. This may be because in the strenuous efforts to ensure that assessments systems are reliable, rigorous and cheat proof, that teachers forget to view assessment in itself as an episode of learning (Stefani, 1998). Often the view is taken that the purpose of assessment is to ‘measure’ learning rather than to support and improve student learning (Gibbs and Simpson, 2004). The danger with a ‘measurement’ model of assessment is that students are lead to believe that factual recall is what is important rather than understanding. This chapter will cover four key issues:

- The importance of assessment of student learning;
- The advantages and the disadvantages associated with online assessment;
- Some examples of online assessment in the biosciences; and
- A note of caution on online assessment.

The central role of assessment

There are now global movements to re-interrogate assessment practices. Brown (2004) reports that internationally assessment is changing as the nature of teaching and learning in post-compulsory education changes. James et al., (2002) outline some of the broad factors that are currently significantly affecting student assessment in Australian higher education. These are:

- The efforts of academic staff to find cost- and time-effective assessment techniques;
- The prominence of generic skills such as communication, teamwork, and critical and creative thinking as part of the expected outcomes of higher education;
- The changing nature of students themselves: in their diverse backgrounds, abilities, expectations and engagement with the learning process; and
- The emergence of new technological possibilities for teaching, learning and assessment.

These key factors influencing assessment practices in Australasia are replicated in the UK and other countries (Miller et al., 1998; Rust, 2002; Brown, 2004). The overall focus of this chapter is that of the potential of technology in enhancing our assessment practices.

Essentially the purposes of assessment remain the same, irrespective of whether they are part of a traditional or online strategy. Some of the key purposes of assessment are to:

- Provide feedback on student learning;
- Grade students;
- Motivate students to learn;
- Consolidate the learning that is occurring;
- Apply abstract concepts to practical problems;
- Estimate students’ learning potential;
- Guide students in course selection;
- Provide feedback for academic staff on the effectiveness of their teaching; and
- Provide information for quality assurance purposes.

(Adapted from Brown and Glasner, 1999)

Unfortunately while it is possible to identify multiple purposes for assessment, the range of methods actually deployed remain very limited (Jenkins, 2004). Although it is to be hoped that technology and its potential will allow for a much greater level of creativity in teaching, learning and assessment there is currently a level of disappointment being expressed. For example Trehan and Reynolds (2002) have observed that:

“Examples of critical pedagogies including those situated online are accumulating but they seldom exhibit corresponding changes in assessment practices.”

It is imperative that progress is made beyond this position. As James and McInnis (2001) state:

“Online assessment represents an unparalleled opportunity for rethinking assessment in higher education. Online and other forms of computer-based assessment are a natural outcome of the use of information and communication technologies to enhance learning and are closely aligned with the objective of providing students with more flexible programmes and opportunities.”
There is a need for institutions to recognise that development time is essential for good e-learning to occur and to properly resource departments and educational development units;

There are potential risks relating to institutional infrastructure, hardware, software and administrative procedures;

Both staff and students need to have the appropriate ICT skills and experience to engage in e-learning and online assessment;

To maintain course integrity, rigorous arrangements must be made to administer online tests or examinations (McAlister et al., 2001);

The potential for plagiarism and other forms of cheating may be increased with online assessment – this will be discussed in a later section in this chapter.

All of the issues discussed above apply to online assessments in any subject area and should be taken into consideration at the planning stage of course development. The next section explores some examples of online assessment which have been developed within the biosciences.

Computer-based assessment applications in the biosciences

It should be noted that there are still relatively few published examples of online assessment within the biosciences, but current practitioners will hopefully find the following examples intriguing and worth following up.

i) Mathtutor

Mathtutor is a new mathematics e-learning resource for mathematics and science education which delivers diagnostic tests, video tutorials, interactive exercises, animations and printable text via DVD and the internet (Tariq et al., 2005).

Mathtutor is another innovative approach to learning and self-assessment. Mathtutor has been described in detail by Vicki Tariq from the University of Central Lancashire who has an extensive research record relating to a concern within the sciences and biosciences about students’ mathematical abilities. She believes that university departments should be
able to assume that most students can manipulate fractions and decimals, handle powers of ten and be able to plot and interpret graphs. However, her findings indicate that many students in the science and bioscience subjects are: “unable to manipulate or appreciate numbers and equations, to use scientific notation or to explain and make predictions from data presented in graphs, charts and tables” (Tariq et al., 2005). Tariq and colleagues believe that a major challenge is to do something that goes a long way in a short time to address this learning and skills deficit.

Mathtutor has been produced by a team led by the University of Leeds and the Educational Broadcasting Services (EBS) Trust who are experts in new media production. A wider team is currently working in collaboration with the EBS Trust to adapt aspects of Mathtutor for life science undergraduates. The issue here as articulated by Tariq, Stevenson and Roper (2005) is that mathematics is an exciting subject that should be taught in such a way as to complement the discipline (bioscience subjects) rather than being seen as an abstract necessity. This team believes that rather than present students with a range of maths topics and then use biological examples to simply illustrate the application of mathematical concepts that it would be better to take some existing biological topics, case studies and scenarios, present them in a highly visual manner and explore the mathematical concepts and applications with these topics, teaching students and enabling them to practise the maths required for them to master and understand the topic.

When complete, this project to adapt mathtutor to the life sciences will allow students to work online to self-assess, diagnose their strengths and weaknesses and integrate the learning of mathematics with actual applications. Full details of this innovative project can be obtained from Tariq (2005) and Tariq et al., (2005). Mathtutor contains diagnostic tests for students, around 1,300 interactive exercises, and is described as an easily navigable forest of maths packages for clear and easy access. More information on Mathtutor can be obtained from the following web site:

http://www.math.tutor.ac.uk/

ii) Web-based crossword puzzles

Alan Wise from the School of Health Sciences at the Robert Gordon University in Aberdeen has written of his experimentation with crossword puzzles (Wise, 2003). Alan believes that crossword puzzles provide a method of self-assessment that involves active learning and may be a pleasurable way to revise. Not only has he experimented with the use of web-based crosswords, he has also explored the literature and conducted his own research on the efficiency of the crossword as a learning tool. He has found there is general agreement amongst both staff and students that crosswords help students to revise material that has already been taught via other methods.

There is, of course, software available to enable the creation of crossword puzzles and prepare them for use in a web browser. The crossword puzzles have been in use with Nutrition and Dietetics students and in the evaluation of this type of learning, revision and self-assessment, the students indicated that crossword puzzles show them what they need to study more thoroughly and that they would be happy to see crosswords being used by lecturers in other subject areas.

A programme was written in Visual Basic that enables construction of interactive crosswords in Java Script for use in a web browser. Wise (1999 and 2003) provide details of crossword construction and student attitudes towards this type of self-assessment aid. Examples of Alan’s crossword puzzles can be viewed at:

http://www2.rgu.ac.uk/windiets/cross.htm

ii) Multiple Choice Questions (MCQs)

For those interested in setting MCQs, Dewey (2000) gives an excellent guide to ‘Writing Multiple Choice Items which Require Comprehension’. He believes that it is possible to construct MCQs, the answers to which are not readily guessed, and which, therefore, require students to comprehend basic factual material. With large classes in any subject area including the biosciences there is a tendency to work towards objective testing in an online environment because the tests are automatically graded and provide immediate feedback to the students (Cooper, 2000).

Tony Gardner-Medwin has added another dimension to MCQs by requiring a confidence judgement from students (Gardner-Medwin, 1995). After each question students are asked to indicate their degree of certainty in their answer (low, medium or high). The marking scheme is simple: 1, 2 or 3 marks for correct answers and 0, -2, -6 marks for wrong answers (depending on the confidence level). Such an approach raises awareness that uncertain but correct answers, or lucky guesses, are not the same as knowledge, and that confident but incorrect answers deserve special attention.

Jenkins (2004) highlights a genetics programme at Wageningen University and Research Centre in the Netherlands whereby Questionmark Perception is the software package used to support the generation of formative assessment tests for students. Weekly tests, linked to lectures and required reading are made
available to students. Tests of the same format are repeated as part of the final examination and account for 10% of the marks. Reports from staff have indicated that students welcome doing formative tests and that it frees up time for staff to focus on other problems.

### iv) Authentic assessment

Technology allows the opportunity to break free from tradition and to provide more meaningful learning and assessment experiences for students. It is possible to set up group projects for students, negotiate an assignment and ask the students to produce a report or their project outcomes as a web page. Transferring a traditional, classroom-based project to an online project increases the potential for students to engage in peer feedback and assessment. For example in a biochemistry class, it would be possible to present a plausible scenario and ask students to work in groups to find solutions to the problem. This could require the student groups to research the problem, share information within and between groups and present their findings in the form of a web-based report to be peer and tutor assessed.

Such a project would encompass a wide array of transferable skills including ICT skills.

An example of a scenario to be put forward is as follows: a citrus canker has affected 70% of the world’s citrus crop. This means that alternative sources of citric acid and citrates are urgently required. Assess the feasibility of using a biotechnological approach in the production of citric acid.

Online bulletin boards could be used as a medium for the iterative exchange of ideas, creating a framework for social engagement and peer assessment.

This is an example of a project which originally was classroom/laboratory based with students’ research findings being presented as a poster (Stefani and Tariq, 1996). Projects of this nature could, without too much difficulty, be adapted to incorporate technology.

This type of project is becoming more prevalent in a range of subjects (McConnell, 2000; Robinson, 1999; Garrison and Anderson, 2003). It taps into students’ desire for social interaction in learning and also encourages them in up-to-the-minute computer applications – as well as providing scope for more authentic learning tasks and assessment. Students can be encouraged to communicate by means of a blog.

A web-log or blog is a web page containing a series of short, frequently-updated postings, in chronological order; providing a personal publishing tool.

The shortage of published examples of online or computer-aided assessment is not necessarily because there is a shortage of examples of innovative practice. It is because not everyone who is experimenting with this type of assessment has necessarily considered publishing their work. However, as these few examples of assessment and the case studies which follow in this Guide highlight, (for example see the excellent case study (6) by Richard Rayne and Glenn Baggott) there are models of good practice both in the biosciences and in other disciplinary areas. For those interested in engaging students in self- and peer-assessment in an online environment, it is well worthwhile exploring the work of Richard Parsons from the University of Dundee. Richard has developed an online system for self and peer assessment of text according to defined criteria. While this was not developed primarily for the biosciences it is applicable to a wide range of subject areas. The system supports students in gaining a deeper understanding of the assessment process by involving them in a meaningful way. The system can work as a stand-alone, web-based activity or can be included as an exercise within a VLE.

This system is flexible enough to incorporate a number of features such as:

- The ability to present criteria to students before they complete an assessment task;
- A keyword, automatic system of computer marking text;
- The ability to comment on the peer’s comments (which are then fed back to the peer marker);
- The addition of images to support the question; and
- The option to text message students their results.

An innovation like this fully supports social interaction and because it involves the students in the assessment process, it is likely to be attractive to them provided of course that they are well prepared for learning in this way (Parsons, 2003).

There is still ample scope for new developments in this area of teaching and learning. The Centre for Bioscience provides the excellent Bioscience Education E-journal:

http://www.bioscience.heacademy.ac.uk/journal/

where this type of work can be shared with colleagues working in the same field.

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Chapter 3  Assessment of student learning in an e-learning context
Recent research on online assessment

It is heartening to see more research on the benefits of online assessment and its impact on student learning. Ricketts and Wilks (2002a), for example have carried out extensive research with their students, evaluating their performance and responses to online examinations. The modules studied are in the disciplinary fields of biology, business, geography and computing while the actual subject area is statistics. Interestingly in some disciplinary areas students were less keen on online examinations than in other subjects. However, it would appear to be the case that both student performance and student opinion are strongly influenced by the on-screen style of the assessment. This type of research is invaluable because it highlights the issue of one-size does not fit all students and helps to guide the design of online learning and assessment tasks. Ricketts and Wilks (2002b) believe a number of different factors influence the students’ opinions of online assessment. These factors include issues such as how well prepared students are for online assessments, different skill levels in using technology and possibly students are influenced in their beliefs by their own performance. These are all important issues to take on board in endeavours with e-learning strategies.

A note of caution on online assessment

Decisions on the scope for online assessment will very much depend on the institutional infrastructure for e-learning.

There is much anecdotal evidence that institutions are keen to develop a curriculum which incorporates e-learning in an appropriate manner but fall back on tradition when it comes to assessing student learning. While this may be frustrating, there are probably sound reasons for the situation. In a truly flexible learning situation where students could access assessment anytime, any place, we have to recognise that the most problematic issue is ensuring that those being assessed are who they say they are. It is almost impossible to ascertain a participants identity when communicating over the Internet.

This is not to say the situation is impossible. Most institutions are campus based and do not aspire to be e-institutions - and therefore, there is no reason why students cannot carry out their summative assessment in a properly supervised computer laboratory.

Another related factor regarding online assessment is the potential for plagiarism and other forms of cheating. Of course the argument can be made that if a course is well designed, cheating should not be a problem. The Open University, for example, uses a combination of online and traditional pen and paper testing of students. Some attention has been paid in recent years to the rise in text plagiarism through ease of access to web-based resources (McMurtry, 2001; Heberling, 2002) but little attention has been paid to potential problems with focused assessments using instruments such as multiple choice tests and calculation questions which are necessary in, for example, engineering and science courses.

A problem for many subject areas in universities will be the lack of computer laboratories with enough workstations to accommodate large classes of students. This means of course that all-at-once assessment with a single test is not possible, raising the stakes in terms of students having the potential to cheat by asking or telling other students about the questions.

These issues are not intended to appear negative or dismissive about online or web-based assessment of student learning but they go some way to explaining why it is that while great advances are being made in terms of adopting e-learning strategies, there are major issues to be considered regarding e-assessment.

There are of course measures that can be taken to safeguard online assessment. For example, if courseware products such as Blackboard or WebCT are being used, it is possible to have good structures around passwords and to set up availability dates and times for assessments. Also many packaged courses or products have the capability of creating large ‘question pools’ for randomised assessment (Olt, 2002) and this can help to eliminate cheating in large classes by never having the same order of questions for different student cohorts.

However, it is likely to be the case that the best measure to take to provide students with positive learning and assessment experiences in an online environment is to continually reflect on the approach used for course design, teaching, assessment and provide ongoing and constructive feedback to students.

Theoretically, the design of examinations rapidly becomes more sophisticated since computers offer the potential to present students with complex scenarios involving interactive resources.

The use of technology could truly revolutionise both the approach to facilitating student learning and the ways in which learning is assessed.
The following section contains a collection of six bioscience case studies. All the case studies have been written by bioscientists who have used IT in their own teaching. The case studies are organised around common headings (‘Background and rationale’, ‘Advice’, ‘Troubleshooting’, ‘Does it work?’ and ‘Further Developments’), but each study reflects the author’s individual style and preference.

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<td>The use of handset technology in an interactive lecture setting enhances the learning of histology</td>
<td>Robert Smith and Barbara Cogdell, Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow, G12 8QQ.</td>
<td>University of Glasgow</td>
<td><a href="mailto:R.A.Smith@bio.gla.ac.uk">R.A.Smith@bio.gla.ac.uk</a></td>
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<td>2</td>
<td>Using Macromedia Flash to design effective learning support resources to teach bioscience</td>
<td>Matthew Hammerton, Formerly School of Applied Science, University of Wolverhampton, now at Faculty of Social Science and Humanities, Loughborough University, LE11 3TU.</td>
<td>Faculty of Social Science and Humanities, Loughborough University</td>
<td><a href="mailto:M.Hammerton@lboro.ac.uk">M.Hammerton@lboro.ac.uk</a></td>
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<td>Really Simple Syndication (RSS)</td>
<td>Alan Cann, Department of Biology, University of Leicester, Leicester, LE1 7RH.</td>
<td>University of Leicester</td>
<td><a href="mailto:alan.cann@leicester.ac.uk">alan.cann@leicester.ac.uk</a></td>
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<td>Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow, G12 8QQ.</td>
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<td>5</td>
<td>An IT solution to a pedagogic problem</td>
<td>Stephen Gomez and David Lush, Faculty of Applied Sciences, University of the West of England, Bristol, BS16 1QY.</td>
<td>Faculty of Applied Sciences, University of the West of England</td>
<td><a href="mailto:Stephen.Gomez@uwe.ac.uk">Stephen.Gomez@uwe.ac.uk</a></td>
</tr>
<tr>
<td>6</td>
<td>Using frequent computer-based assessment to ‘set the pace’ in a first-year bioscience module</td>
<td>Richard Rayne and Glenn Baggott, School of Biological and Chemical Sciences, Birkbeck College, London, WC1E 7HX.</td>
<td>School of Biological and Chemical Sciences, Birkbeck College, London</td>
<td><a href="mailto:r.rayne@bbk.ac.uk">r.rayne@bbk.ac.uk</a></td>
</tr>
</tbody>
</table>

These case studies illustrate a range of approaches to using technology to teach bioscience. It is envisaged that these cases studies will provide guidance, inspiration, as well as practical advice on implementing e-learning in the biosciences. There is also an accompanying web site to this guide (http://www.bioscience.heacademy.ac.uk/TeachingGuides/). The web site contains further practical material to aid the reader in using technology in teaching. The site includes expanded versions of the case studies, video clips, further bioscience case studies and supporting material.
We teach a short histology course called ‘Human Tissues in Health and Disease’ to second year science students (Cogdell and Smith, 2004). The course is worth 10 credits and occupies one sixth of the students’ study time during the half year in which it runs. Each year we have between 250 and 350 students and all the lectures are given twice so that students can have flexible timetables. Faced with the problems of the large numbers of students, and the lack of facilities, time and staff to present histological material using microscopes and prepared slides, we resorted to a mainly poster format during laboratory sessions. The students initially found this difficult and so we introduced a pre-lab session during a lecture, projecting micrographs and attempting to encourage simple tissue analysis by asking questions. The class proved very reluctant to respond. Even if a few students did offer answers to the lecturer’s questions, the remaining 100 or more students remained silent. We felt it would be a much better learning experience if all the students were able to take an active part and respond. In order to achieve this we decided to use handset technology and run the session in an ‘Ask the Audience’ format from the television programme ‘Who wants to be a Millionaire’.

How to do it

At this time Steve Draper from the Psychology Department at the University of Glasgow was piloting the use of electronic voting systems in lectures (Draper and Brown, 2004) and we were included as part of his study. The Personal Response System used is ‘InterWrite PRS’ (details at http://www.gtcocalcomp.com/interwriteprs.htm). The system consists of infrared handset transmitters resembling small TV remote controllers, which are handed out to the students. We use two portable receivers which are set up at the front of the lecture theatre in positions where they can receive beams from the handsets used by the students. The receivers are linked to a laptop and the results from the laptop are displayed on a screen via a data projector. We also use two further screens. Onto one the photomicrographs are projected and onto the other the questions. The use of a Powerpoint format could reduce this number to one.

We have been fortunate in having the help of a trained assistant who transports the equipment and sets it up. He is able to set up the receivers and laptop in less than 5 minutes, which is essential as we do not have access to the lecture theatre beforehand and another class of students is due in at the end.

The lecturer asks the students questions about the displayed photomicrographs in a multiple choice format where there are several options to choose from. The students select an answer from one of these options and press the corresponding button on their handset while pointing the handset at a receiver. Each handset has its own number and when the receiver gets a response from a handset it will display that handset’s number in a grid on the screen. The students look for their number in the grid to check that their vote has been received. The computer also keeps a tally of how many votes have been cast. If a student votes again during the voting period it will not register as a new vote. In this way students can only have one vote.

Although the handsets are numbered all the students’ responses are anonymous. This is because we have no way of knowing which student has which handset. Anonymity is an important issue as it encourages a reticent student to make an answer without fear of ridicule from the lecturer or fellow students.

We allow about two minutes for an audience of 200 to vote, although this time period can be varied. When the collection of votes has finished a bar-chart appears on the screen giving the number of votes for each option. The lecturer is able to see immediately whether the class has understood an issue. Likewise the student receives instantaneous feedback and can see where they stand in relation to the rest of the class.

We usually manage to complete between 10 and 20 questions in a 1-hour session. This includes an initial question which is fairly trivial, designed to check
whether the students have grasped how to use the handsets and a final question asking for feedback on the session itself.

**Advice**

It is important not to let the handset use become more important than the actual content of the pre-lab session. The lecturer must be prepared to return to the previous way of delivering the session if for some reason the technology does not work. However it is best to try and avoid this situation so it is helpful to have someone very conversant with the technology to set the system up and operate the laptop during the session. At least one other helper is also useful to hand out the handsets and collect them at the end. Although this is similar to giving out a handout it does take time with a large class. With competent helpers the lecturer is then free to concentrate on engaging with the students.

Teaching staff found the system of instant feedback from the students very helpful. If students answered correctly they were able to go straight on while if most of the students had chosen an incorrect option the lecturer was able to explain why this was a wrong answer.

**Troubleshooting**

We have successfully run these pre-lab sessions for 4 years now with one session and its repeat each year. There have been no difficulties with the technology. The system is very easy to operate. On a couple of occasions we have run short of time due to the slightly late exit of the previous class from the lecture theatre and difficulty getting our class in and seated.

It might be less hassle to use if the receivers were permanently installed in the lecture theatre. Indeed this is the case for one lecture theatre on the university campus, but it is not possible for us to use that particular lecture theatre. Having portable receivers makes the system more flexible and allows a bigger variety of classes (different subjects and numbers of students) within the university to take advantage of the system.

**Does it work?**

We have had very good attendance at the sessions with handsets with almost a full turn out. Recently there is a perception among teaching staff that second-year student attendance at lectures is generally poor. Sometimes less than half the class may be present, so our improved attendance level is a positive outcome.

We have also had very favourable and perceptive responses to evaluations of the sessions from students. One form of feedback was to use the voting system to answer the following question: ‘What was for you the balance of benefit versus disadvantage from the use of the handsets in the pre-lab tutorial session?’

Typical responses to this question from the class of 2002 are shown in Figure 1. The plot shows that 90% of the students felt they either definitely benefited or that the benefits outweighed any disadvantages.

We also used a separate, anonymous, web-based questionnaire with some open-ended questions. One question was ‘What do you consider were the benefits, if any, of using the handsets for the students/lecturers?’ Below are some of the typical answers:

- “Made sure you paid attention since you would have to submit an answer. Also helped see how you were doing compared to rest of group.”
- “Students could be interactive and lecturers get instant results of questions and class percentages.”
- “You had to give the answer that you thought was right – if you got it wrong it wasn’t embarrassing because you weren’t giving the answer verbally.”
- “It gave you an idea of the knowledge you already had before the test and it definitely added a fun element!”

We also asked what were the disadvantages. Most of the students said none and a few commented on

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**Case Study 1**

The use of handset technology in an interactive lecture setting enhances the learning of histology

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**Figure 1. Evaluation of the use of handsets during a pre-lab session**

![Figure 1: Evaluation of the use of handsets during a pre lab session](image-url)
the setting up process. There were also a couple of comments, such as the one below, about the students not taking the system seriously:

- I didn’t think there were any disadvantages for the students. I think it might have been annoying for the lecturers when people just mess about with them.

However, in reality this was not a problem for us, given that the system was set up to count only one response from each handset.

As lecturers we felt that the use of the handsets enhanced this particular teaching session. We were particularly keen to get the students to look at the photomicrographs and to learn to identify the various tissues and cell types. Using the handset technology encouraged all the students to make judgements about what they were looking at and to become actively engaged in the material in a way which otherwise would not have been possible.

Further information

Mattey (2003) and Draper and Brown (2004) have carried out an extensive evaluation of the use of electronic voting systems in a variety of classes at the Universities of Strathclyde and Glasgow respectively. An informative video showing the use of the system in a statistics class can be accessed via Steve Draper’s website (Draper, 2005).
Background and rationale

Macromedia Flash emerged in 1997 as a simple on-screen animation package called FutureSplash. Since then, it has expanded into an extremely powerful tool for designing and deploying a whole range of media content both online and offline. Flash MX was launched in 2002 with expanded features and enhanced tools allowing for the production of extremely effective learning objects. The program gives learning technologists and academics the power to use innovative approaches to learning design conforming to the specific resource development guidelines e.g. Web Accessibility Guidelines. The University of Wolverhampton has developed several Flash resources and used them successfully in teaching.

Case studies

i) Virtual Crime Scene Investigation

Forensic Science is an extremely popular subject offered at the University of Wolverhampton and partner colleges. Although the course uses specialised rooms to stage mock-up crime scenes, opportunities for their use are limited by timetabling problems. Furthermore, the rooms only allow for creation of a limited range of realistic mock crime scene scenarios. For these reasons, simulated crime scene scenarios with combined assessment exercises were produced delivering the following benefits:

- Effective crime scene training over a shorter period of time;
- Replacement of the costly and time-consuming practice of creating mock crime scenes for the purpose of training and assessment thus improving the efficiency of staff time;
- Easy access to the performance of every individual who uses the product allowing for corrections of any misconceptions and more effective and timely feedback; and

These online resources were developed by combining video, sound, images and panoramas to enhance student’s experience in assessing a realistic simulated crime scene. Assessment of student knowledge is via a series of questions intermingled with video clips and crime scene information. Specific feedback is given after every question with general feedback at the end.

The main reasons for using Flash in this project were:

- Integration of the majority of multimedia file formats: Rich interactive learning experiences can be built due to the program’s ability to import and integrate video, sound, graphics and images in a number of formats. Flash files can also be embedded in each other allowing smaller learning objects to be produced and shared between larger learning objects or programs.

- Small file sizes: Flash can deliver high quality animation from small files. This allows for quick access to learning objects even for students on modem connections. This performance can be enhanced through the program’s ability to stream only relevant information, as and when it is needed.

ii) Virtual Learning Centre Tour

The University of Wolverhampton’s Harrison Learning Centre provides resources and support to the 14,000 students entering the University from a wide range of educational, social and cultural backgrounds. The physical layout, the wide range of subjects, multiple enquiry points and the combination of electronic and printed sources can be overwhelming to the new student. The virtual tour guide to the Harrison Learning Centre and its resources has been produced to overcome this situation and promote engagement and active learning. The tour uses multiple navigation options enhanced with advanced new media web features to include 3D graphics and animation. The tour has been embedded into the Techniques in
Biosciences study skills module and is used to teach both generic and subject-specific library skills to our students.

The main reasons for using Flash were:

**Advanced graphical representation of complex concepts:** Due to the quality of the drawing tools and the ease with which on-screen graphics can be animated, Flash gives the user a realistic way of representing complex subject concepts.

**Accessibility:** The program provides features to support compliance with Web accessibility guidelines by allowing for auto-labelling of buttons, tab-order controls and access to assistive technologies such as screen readers (MacGregor et al., 2002). The program’s flexibility in learning object design means that the end user has the ability to choose how they want the information to be presented.

**iii) A formative assessment exercise and interactive online alternative to a laboratory-based demonstration in food microbiology**

Demonstration of microbiological methods used in the analysis of foods is an essential part of the University’s Food Microbiology course. However, in recent years, laboratory availability has become limited. Therefore, the production of an interactive online resource to simulate and enhance these laboratory-based demonstrations seemed a natural progression. The programme combines interactive graphics on microbiological methods with a formative assessment exercise. The resource delivers the following benefits:

- Providing a stimulating learning experience and encouraging a deeper approach to learning;
- Contributing to widening access and providing the opportunity for distance based learning;
- Improving efficiency of staff/student contact time;
- Allowing self-paced study;
- Providing student feedback on progress;
- Acting as a clear guide as to academic expectations; and
- Promoting independence in learning.

The main reasons for using Flash in this project were:

**Interaction:** Flash has been used in this learning object due to its ability to record student actions and respond to them immediately. These responses are recorded onto a database to allow for further tailoring of support for each student.

Other reasons for using the program include:

**Compatibility and consistency:** Learning objects produced in Flash will display consistently across different screen resolutions, browsers and operating systems and on different devices from the desktop computer to the mobile phone.

**Re-usability:** The program has several attributes that speed up the production process of e-learning resources while aiding a consistent appearance across learning objects. Symbols and components, the building blocks (assets) of any Flash file, can be re-used in several learning objects, while still maintaining design flexibility. Many e-learning templates and components have been produced and are freely available on the web. All assets of a Flash file are stored in the file’s library permitting easy access to the file’s resources.

**Advice on using Flash**

When producing Flash learning resources, there are a number of issues that need to be considered. These can be summarised as:

**The plug-in:** In order to view Flash learning objects, a browser plug-in (or player) is required. This plug-in is shipped with the latest browsers and operating systems and detection scripts allow for quick and easy download of the plug-in if required. With over 97% of all internet-enabled desktops worldwide containing the Flash plug-in in 2005, the plug-in is now the world’s most pervasive software platform (Macromedia, 2005).

**Learning curve:** Although the program is relatively simple to use, harnessing its full range of features including component production and ActionScript programming can take a while due to the power and freedom that Flash provides for the developer.

**Usability:** Due to the ease with which animations can be produced and the freedom that Flash gives to the developer, there has been a mass of gratuitous animation and unusable resources created that serve little purpose for the end viewer. This has caused influential usability pundits to criticise the benefits of using Flash stating that it hinders more than it helps (Nielsen, 2000). Although, this is mainly directed at web site production, it is an important issue that needs to be considered when producing any type of Flash resource. The main question being: ‘Is Flash the best
tool for the production of this learning object?’

Development time: Flash includes several attributes (symbols, components and templates) that speed up the development of learning objects. Nevertheless, when comparing Flash against Microsoft Powerpoint for the production of animations, using Powerpoint is likely to require less time and effort. However, when considering the effectiveness of that animation for the student, then using Flash is likely to produce a better result.

Troubleshooting
There are currently two main books available on the development of e-learning resources using Macromedia Flash. Castillo et al. (2004) provide an introductory look at using Flash MX to create e-learning material. They discuss how to use the program’s e-learning templates for effective assessment and interactivity. Bardzell (2003) is a more advanced book which looks at combining Macromedia Flash with Macromedia Dreamweaver and Coldfusion to produce custom made learning resources.

For general troubleshooting Reinhardt and Dowd (2002) provide information on all aspects of Flash MX from the program’s fundamentals to the building of dynamic applications.

Does it work?
Questionnaire responses indicate that effective learning materials can be generated using Flash.

The majority of Forensic Science students found the Virtual Crime Scene Investigation to be beneficial to their studying (95%) and they wanted to see further supporting material in other modules produced using the program (100%). A few of their comments for the resource were:

“Well thought out, exciting, logical and interesting!”
“Good program, interesting, complements the lectures well, informative, would be good for other forensic modules to include programs like this.”

For the Learning Centre Tour, 82% of students questioned stated that the Learning Centre Tour graphic representation has allowed them to work out where resources in the Centre can be found, this being the main learning objective of the tour.

All of the students who used the Food Microbiology resource either strongly agreed or agreed that this type of material should be used to support lecture material. The programme was considered by 75% of the students to be a good replacement for a laboratory-based demonstration.

In conclusion, Macromedia Flash provides an effective tool for the production of learning support resources ranging from simple simulations to full blown applications (e.g. PebblePad, the e-portfolio program used by the University of Wolverhampton). The features and tools of the current program (version 8) give the educator the power to be truly creative, and will undoubtedly be expanded in subsequent versions.

Links to material
Virtual Learning Centre Tour:
http://asp2.wlv.ac.uk/webteam/service_uploads/learningcentre/virtual_tour.html

Acknowledgements
The author would like to thank the following staff for their help in producing this case study: Dr R Sutton; K Trueman (Crime Scene Investigation); Dr H Gibson; J T Walton (Food Microbiology assessment) and J A Granger (Learning Centre Tour).
It is difficult to believe only some 15 years have passed since the origin of the World Wide Web. Internet technology has developed at a pace which shows few signs of slowing. One feature of the ‘browser wars’ of the 1990s was the development of what became known as ‘push technology’ (also called webcasting or netcasting). The feature of this approach is the use of a server to deliver or ‘push’ information to a client rather than waiting for the client to request specific information. In a short time, economic forces drove this technology to become heavily commercialised. This, together with bandwidth limitations for many users resulted in this approach to information delivery falling out of favour for a while.

RSS is an example of push technology and its origins began with the publication of the first RSS protocol (Resource description framework Site Summary) in 1999. Within two years, several revisions of this technology had become known as ‘Really Simple Syndication’. The development of this technology coincided with the start of weblogging or ‘blogging’ (McAndrew, 2006). RSS allowed bloggers to provide a summary of their output to readers in a readily accessible form. In 2000, the use of RSS was also taken up by several major news organisations, including Reuters, CNN, and the BBC, to provide access to rapidly changing news stories (Wikipedia: RSS, 2006). More recently, bibliographic databases and academic publishers have also begun to offer RSS feeds of the latest publications (Table 1).

To date, the most common way to access RSS feeds has been with an aggregator, a program which allows readers to subscribe to feeds, check for new content at user-determined intervals, as well as retrieve and display the content (Wikipedia: Aggregator, 2006). A Google search (http://www.google.com) for ‘news aggregator’ returns a large number of possible choices, many of which are free. This capability is already present in advanced web browsers and is due to be built in to future versions of Microsoft Internet Explorer. From a pedagogical viewpoint, although integration of aggregator function into web browsers is an advance, it still requires that users make an active decision to access information rather than having it presented directly to them. For this reason, I will describe the methods I have used to integrate dynamic RSS content into existing web pages and VLEs used by students. This approach enriches the content of what would otherwise be static pages and has the capability to turn a simple web page into a ‘destination’ which repays frequent visits.

<table>
<thead>
<tr>
<th>Table 1. RSS Feeds From Academic Publishers</th>
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</thead>
<tbody>
<tr>
<td>Biomed Central</td>
</tr>
<tr>
<td>Cell</td>
</tr>
<tr>
<td>Nature Journals</td>
</tr>
<tr>
<td>New Scientist</td>
</tr>
<tr>
<td>PNAS USA</td>
</tr>
<tr>
<td>Science</td>
</tr>
<tr>
<td>Other RSS Journal Feeds</td>
</tr>
</tbody>
</table>

A non-exclusive list of some academic journals which publish RSS feeds. Typing the journal name plus RSS into a Google search frequently has a positive result.

protocol had been published and the methodology had become known as ‘Really Simple Syndication’. The development of this technology coincided with the start of weblogging or ‘blogging’ (McAndrew, 2006). RSS allowed bloggers to provide a summary of their output to readers in a readily accessible form. In 2000, the use of RSS was also taken up by several major news organisations, including Reuters, CNN,
Case Study 3
Really Simple Syndication (RSS)

The BBC News web site (http://news.bbc.co.uk) provides a rich source of current information for students. Each of the main pages (e.g. Education, Health, Science/Nature and Technology) display a small orange RSS logo (Figure 1). Clicking on this image will allow the reader to view or subscribe to a preconfigured feed of information relating to the topic. The drawback of this source is that even within a particular section of the BBC web site, the range of items is extremely broad, almost certainly beyond what is likely to be of interest for a particular course or module. The solution to this problem is to build keyword-specific RSS feeds. Unfortunately, this feature is not currently available directly from the BBC News web site, but is offered by other online services such as Google News (http://news.google.com) and Yahoo News (http://news.yahoo.com/rss). At these sites, it is possible to enter a search term and build an RSS feed from the resulting output. This means that it is possible to define RSS feeds for any topic of interest, targeted as broadly or as narrowly as required.

Although powerful, keyword-specific RSS feeds still suffer from the disadvantage that they require students to view the information via a news aggregator or specific browser. In my experience, the maximum pedagogical benefit of using these resources comes from integrating them directly into existing HTML-based teaching materials. This can be done using freely available scripts to capture and convert keyword-specific RSS feeds into HTML code. No particular technical ability is required to achieve this beyond a basic knowledge of HTML and the ability to create web pages into which the material can be integrated.

A Google search for ‘RSS HTML display’ reveals a large number of free resources available online to convert RSS feeds into HTML. These rely on a combination of Javascript and/or PHP to convert the RSS code into HTML, but all users need to do is copy and paste the URL of the RSS source into a web-form, format if required, click a button and paste the resulting output into the desired location. Some of these scripts are designed to be downloaded and run on a local web server but many are freely available to use online. The advantage of the former approach is that an author can have confidence that the script will remain available since it will be running on a machine over which they have some control, the disadvantage being that installation of the script and some configuration may be necessary. The advantage of the latter approach is that no tinkering is necessary, but the availability of the converted feed is subject to the vagaries of the Internet.

There are some legal considerations surrounding the use of RSS feeds for teaching. The first issue is copyright permission. All of the major sites which publish RSS feeds will have a Terms and Conditions document somewhere on the site. This must be read and complied with. Sites which publish RSS feeds go to the trouble of doing so because they want people to use them. The usual condition of use is that the display contains an attribution and sometimes a link back to the RSS source. Another issue is that no matter how tightly defined the search terms, it is not possible to completely control the content which will be displayed. On occasions, unpredictable, seemingly improbable and potentially offensive content may be displayed! One solution to this problem is by use of a standard disclaimer which contains a statement such as ‘this institution is not responsible for the content of external internet sites, and does not endorse opinions expressed or services provided at those sites’. Such a policy needs to be negotiated and agreed at a local or institutional level.

Example 1: The Update Box
I have developed this style in my online lecture notes for final year students in order to integrate four different streams of dynamic information into a concise format (e.g. http://www–micro.msb.le.ac.uk/3035/Poxviruses.html, scroll to bottom of page, Figure 2). The ‘News’ component displays a keyword-specific Yahoo or Google News feed rendered as HTML by an embedded Javascript as described above. The ‘Publications’ component displays the RSS feed for a preconfigured PubMed search for the topic of interest, converted by the same script. The two ‘Search’ links give access to preconfigured Google and PubMed searches tailored to the subject of the page. This gives students access to a wealth of constantly updated information without further intervention and forms the source material for online discussions and essays. I have developed the Update Box format as an HTML component which can easily be dropped into any existing web page and tweaked to reflect the content of the page.

Figure 1. RSS Logos
On most sites, clicking on these images will display an RSS feed.
Example 2: Index pages with dynamic content

Compare the appearance of, for example, the BBC News web page (http://news.bbc.co.uk) to the top level page on your own web server. It is easy for academic web index pages to be highly static pointers to online content with no educational value in themselves, and to present students with a boring entry point to what is supposed to be an engaging educational journey. To avoid this, I incorporate relevant keyword-specific Yahoo or Google News feeds into such pages (e.g. http://www.micr.msb.le.ac.uk). This means that the dynamic content of the page will have automatically updated each time a student visits it, and will hopefully engage the student’s attention and interest. Online learning materials compete for students attention with commercial pages which are colourful, dynamic and fun. Like it or not, to compete successfully with these distractions, academics need to employ the same tools, such as RSS, which give rise to the siren call of other internet sites. Keep them coming back!

Example 3: A VLE Destination – hearts and minds

The final example I will discuss is that of a Virtual Learning Environment (VLE) site which is not linked to a particular course or module, but instead is intended to support students on a particular degree course. Students are not forced to visit the site – it is not linked to assessment! In order for them to do so, the site must have sufficient value to them to visit it voluntarily. I have employed various means to achieve this objective. Students have part ownership of the site - they can create their own homepages to introduce themselves to their peers on the degree course. They can also use the discussion boards to interact with other students and members of staff. The site also has a dynamic news page which contains a number of keyword-specific RSS feeds relevant to the degree course (Figure 3). Inclusion of this type of content is aimed at making this site a ‘destination’, in the current web jargon, rather than just an information placeholder, and in doing so, promote academic achievement, inclusivity and employability of students.
After subscribing to and displaying RSS feeds, the next step is to publish your own feed. There are a number of reasons (apart from pure ego!) for which this might be pedagogically useful. You may want to take control of dynamic information you would like students to be aware of. Effectively, your feed will be an academic weblog (blog). The simplest way to achieve this is to start a blog at one of the free online sites such as http://www.blogger.com or one of the many other free blog hosting sites a Google search will reveal. Most of these sites automatically generate some form of RSS feed which you can try to persuade students to sign up to!

Alternatively, you may want to use your own RSS feed to ‘push’ information such as course news, reminders and notices to students. In this case, it is probably desirable to publish in-house rather than via a public blog. There are two ways to create a custom RSS feed. The current RSS standard (RSS 2.0) is a fairly straightforward XML format which it is possible to write by hand using a text editor (RSS 2.0 Specification, 2005). The best way to get started is to look at the source code of an existing feed, e.g. http://www-micro.msb.le.ac.uk/rss.xml. A more sophisticated approach is to use an online service or a software package to write the code for you. Again, many of these resources are free and a large number will be revealed by a Google search for ‘publish RSS’.

With a minimal amount of effort to set up appropriate feeds, incorporation of dynamic information into online learning materials via RSS can reap huge benefits in linking academic study to the rapidly changing world into which students emerge blinking, clutching their degree certificates.

Figure 3. RSS Integrated into a VLE ‘Destination’ Site
A VLE site which complements a degree course. Dynamic content is integrated into the site (red arrows).
Background

This lab session forms a three-hour practical session for Level 1 Biology students. These students study biology in first year, along with chemistry or science fundamentals and one other subject, which need not be a science subject. The intended learning outcomes are:

- To give practical experience with web-based data mining and the manipulation of data in a spreadsheet; and
- To focus attention on the pending crisis in world food supply.

And at the end of the end of the practical, students should be able to:

- Describe how the human population and global food demand will increase over the next century;
- Identify the difficulties that world agriculture will face in meeting this demand;
- Develop an understanding of the potential solutions to the food supply problem and the environmental, social and political issues that these will generate; and

Using online databases and predictive modelling to develop student understanding of human population growth and global food demand

Anne M. Tierney, Andrea C. D. Brown and Peter J. Dominy

How to do it

a) Data collection

Students are directed to the United Nations Food and Agriculture Organisation (FAO) web site data collections page (http://faostat.fao.org/). From the Agriculture data collection students are asked to collect the following data sets:

<table>
<thead>
<tr>
<th>OPTION</th>
<th>COUNTRY</th>
<th>ITEM</th>
<th>ELEMENT</th>
<th>YEAR</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops, primary</td>
<td>World</td>
<td>Cereals, total</td>
<td>Production</td>
<td>1961- present</td>
<td>CSV file</td>
</tr>
<tr>
<td>Crops, primary</td>
<td>World</td>
<td>Roots &amp; tubers, total</td>
<td>Production</td>
<td>1961- present</td>
<td>CSV file</td>
</tr>
<tr>
<td>Crops, primary</td>
<td>World</td>
<td>Pulses, total</td>
<td>Production</td>
<td>1961- present</td>
<td>CSV file</td>
</tr>
<tr>
<td>Crops, primary</td>
<td>World</td>
<td>Oiocrops primary, total</td>
<td>Production</td>
<td>1961- present</td>
<td>CSV file</td>
</tr>
<tr>
<td>Livestock, primary</td>
<td>World</td>
<td>Meat, total</td>
<td>Production</td>
<td>1961- present</td>
<td>CSV file</td>
</tr>
<tr>
<td>Crops, primary</td>
<td>World</td>
<td>Cereals, total</td>
<td>Yield</td>
<td>1961- present</td>
<td>CSV file</td>
</tr>
<tr>
<td>Land use</td>
<td>World</td>
<td>Land use</td>
<td>Permanent pasture</td>
<td>1961-present</td>
<td>CSV file</td>
</tr>
</tbody>
</table>
The data are returned in a spreadsheet with file type .csv. For the exercise to work, it is vital that students save the file as an Excel file (.xls) and rename the worksheet.

To find out which species of crops are included as cereals, students can obtain a list by going to the database query page and submitting the following query:

<table>
<thead>
<tr>
<th>OPTION</th>
<th>COUNTRY</th>
<th>ITEM</th>
<th>ELEMENT</th>
<th>YEAR</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual time series</td>
<td>World</td>
<td>Population estimates</td>
<td>Total</td>
<td>1961-present</td>
<td>CSV file</td>
</tr>
</tbody>
</table>

The list returned by the query includes wheat, rice, barley, maize, pop corn, rye, oats, millet, sorghum, buckwheat, quinoa, fonio, triticale, canary seed, mixed grain and cereals nes.

b) Data manipulation – graph plotting

The students plot the categories of food production on a graph, adding appropriate labels and titles. This graph shows that cereals contribute the majority of food produced in the world, and also shows the relative contributions of each category.

Students also plot another graph with cereal yield on it. By comparing the food production and yield graphs, students can see that since 1996, total food production has been levelling off, due to the fact that yields have reached maximum. Any further increases in production will be due to yield increase from more intensive farming methods. Putting aside the environmental issues associated with intensive farming methods, it may be possible to introduce more intensive farming in the developed world, but because of cost and resource implications it is difficult to see how intensive farming methods could be employed to any great extent in other areas.

Going back to the yield data, students can compare the yield for cereals with meat yield. There is no direct data for meat yield in the FAOSTAT database, so to calculate meat yield, students take meat production and divide it by the land under permanent pasture. Students should note that the units are not directly comparable and make corresponding adjustments. (Land Use is given per 1000Ha, meat production is given in Mt and cereal yields are given as Hg/Ha; 1Hg=0.1kg, so cereal yield values must be divided by 10 to give equivalent values to meat yield.)

The five food items listed in the table above represent ~90% of total global food production. The values for each of the categories are added together to give approximate total food production values for 1961-present. These data are added to the Food Production graph. The graph shows that total food production is not increasing. The students then look at world population figures and extract the population data from the FAOSTAT database:

This returns data per 1000 population. This figure is copied into the worksheet and adjusted to give total population figures. This is used to calculate total food production per capita.

Students plot a new graph using the figures for population, total food production and food/year/capita. They are then instructed to extrapolate the lines for these sets of data to predict changes up to 2050. From the resulting graph it can be seen that world population will continue to increase while total food production will remain at around the same level, resulting in a decreased value for food/year/capita.

From the graph students can see that in 2050, estimated world population will be ~15 billion individuals (estimated to be the carrying capacity of the planet) and food production will have fallen to ~200kg/year/capita. Therefore, food demand cannot be met if current trends continue. Current population growth is calculated at ~1.3%, while food production growth rate is ~0.5%.

c) Predictive modelling

Students are directed to open a second, preformatted spreadsheet called 'food supply.xls'.

They are asked to enter the values for population growth and food production growth rate into the model. Using these figures students will see by 2100 there will only be ~140kg/year/capita food compared to the present value of ~230kg/year/capita.

The students are then asked what changes can be made to agricultural production to increase the amount of food produced. Students are given scenarios and
Case Study 4

Using online databases and predictive modelling to develop student understanding of human population growth and global food demand

asked what will happen if certain measures are put in place.

Firstly, they are asked to change the yield of arable farming, by using Current Best Yield for all arable land. This gives a predictive figure of ~500kg/capita/year in 2100, compared to ~690kg/capita/year in 2003 (These are Best Yield figures, obviously, much of the land under cultivation does not operate at these levels). For these results every piece of land would have to be under maximum yield of cultivation. This is not sustainable and the long-term consequences of environmental problems such as nutrient run-off and salination of arable soils result in a loss of agricultural land.

Students change the yield back to the current average figure and then try to increase food production by converting pasture land to arable land (bearing in mind the relative contributions that cereals and meat production make to total food supply). Converting approximately half of the available pasture to arable production results in a disappointing increase from 140 to 165kg/capita/year in 2100. To convert any more pasture would not be feasible as much of the land used to graze animals is unsuitable for arable farming (e.g. Scottish Highlands, Welsh Mountains, both used for sheep production).

Since converting pasture to arable land makes very little difference, the students are directed to convert rainforest to arable production. If approximately half of the available rainforest is converted to arable production, the food supply in 2100 rises to about 175kg/capita/year. Again, a disappointing increase given the controversy and consequences of rainforest deforestation.

Students are directed to increase yields again using increased land from pasture and rainforest. If they double current yields, they can increase food production to ~450kg/capita/year in 2100.

The only way students can realistically increase food production using current crops is to convert half the pasture AND half the rainforests to arable land AND double current yields. It is unrealistic to suppose that intensive farming methods can be employed worldwide, destruction of the rainforests is not an option, much of the land used for animal production is unsuitable for arable cultivation and grain yields are already at their maximum. Therefore, students are asked to think about alternative methods of increasing food supply. The expectation is that they will consider genetic modification of plants (e.g. introduction of salt or drought tolerance) and the development and cultivation of new/minor crops such as sorghum.

Troubleshooting

It is important to marry the practical exercise with the lectures, which provide a sound grounding in the issues surrounding global food production and increasing global population. When the students attended this practical class, they had already had the lectures and were familiar with the topic. It would have been difficult for them to grasp the point of the exercise without the background information.

This should not be used as an exercise in learning to use Excel, but should focus on the scientific data behind the exercise, and the problems that may arise in the future due to pressure on world resources. When developing the exercise, we put in detailed instructions on how to gather each line of data, and add them to an Excel graph, data set by data set. Students did not find it easy to follow page upon page of these instructions, so this year we have simplified things by allowing students to gather all the data before embarking on the graph drawing and data manipulations. This allows students to progress on to the modelling part of the class, where they can see the consequences of increasing population and changing patterns of land use.

Problems that we faced were mainly in the use of Excel. Many students failed to save the .csv file as an Excel spreadsheet, or to rename the worksheet, which resulted in them being unable to manipulate the data until this was corrected. Students who were proficient in Excel charged ahead with the exercise without paying much attention to the data that was being gathered. As some of the data come from slightly different sources, when students came to later manipulations, some of the categories had ‘slipped’ sideways, so that data from a particular year were not always in the same column for each data set. Conversely, students who were not comfortable using spreadsheets found the exercise too demanding, and got lost in the instructions we provided.

During the first year that the exercise ran, the students spent so much time on the data collection that they did not have much time to get to the data manipulations and predictions using the predictive model. The protocol was rewritten to simplify the task of data gathering and the lab run for a second time. A substantial number of students still struggled with the data manipulations, so it was decided that for Level 1 students, they should
be given the spreadsheet already populated with the data, and asked to retrieve only one category of data and add this to the spreadsheet. Hopefully this will shift the emphasis of the exercise from that of using Excel, to one of understanding global food supply.

The number of computers available to students is also a potential problem for us. At the moment we run the lab so that students share a computer between two. This has the advantage that students with a weaker grasp of Excel can be helped by a partner with more experience of the package. Ideally we would wish the students to work on the problem individually, although sharing computers does result in more discussion.

The lab works in that it shows that there may be solutions to the predicted food crisis, but also shows the moral dilemma that will be facing humanity in the future. It is also imperative that lab leaders and graduate teaching assistants are familiar with the technical issues surrounding the lab, such as saving files in the correct format, to facilitate the progression of the students through the exercise.

### Future Developments

With much in the news at the moment of the impending oil crisis, this model could be adapted to allow students to study the changes in oil reserves, energy consumption and alternative sources of energy.

A more sophisticated predictive model is in development, which will allow changes to appear more gradually. At the moment, when figures change, they apply from ‘now’ which is unrealistic.
The problem and context

The Faculty of Applied Sciences (FAS) has run Sandwhich degree programmes in Applied Biological Sciences for over 30 years. Few doubt the importance of the placement year for the workplace experience gained, but we have also found statistical evidence that placement students subsequently perform better academically not to mention enhanced employability prospects on graduation. Employers, understandably, prefer graduates with experience of the workplace during their academic programmes.

Despite these advantages, and having visited placement students and seen evidence of high-level learning – e.g. names on research papers and presentations at conferences – we were concerned that our placement year was not properly recognised in terms of academic credit.

We therefore decided to rectify this by fully integrating the placement within our degree structures by awarding academic credit.

Our solution

Our suggestion to accredit the placement year was met by a range of reactions from ‘about time’ to ‘it can’t be done’ and ‘it’ll undermine the academic integrity of the whole degree’. Most opinions were negative and concerned a variety of aspects:

- The placement occupied time outside formal academic learning, so awarding academic credit was inappropriate;
- T&L quality assurance procedures had no equivalent for placement learning;
- Our placements are diverse in terms of type (e.g. hospitals and industry) and geographical location (e.g. UK and USA), so ‘how could consistent standards be applied in a cost-effective manner?’

How would placement credits be accommodated within the degree? If assigned Level 2 credits, then how would students cope in Year 2 with the expectation of gaining credits in the Sandwich year? If Level 3 credit was assigned, then the taught content in the Final Year would be reduced.

The case for change

It is tempting to continue with existing systems for historical reasons, even when they are adequate rather than ideal. Our assessment of placement learning, we felt, fell into this category. Placement students were allocated a Visiting Tutor (VT), but communication tended to be sporadic, with contact made half-way through the placement to arrange a visit and once again at the end, but with little formal guidance during the placement period itself. This relaxed approach reflected the notional credit-rating assigned to the year. The visit generally affording the VT their first opportunity to discover what the student was doing, turning it into more of a fact-finding operation than an evaluation. Also, the ‘special’ nature of the visit did not reflect the student’s day-to-day work. Essentially, there was little opportunity for the VT to guide the student or support their learning.

We aimed to:

- Monitor students learning in an iterative fashion to steer and provide feedback;
- Produce a transparent pedagogical model based on that of taught modules, thereby assessing student workplace learning with sufficient rigour to satisfy our academic procedures for the award of academic credit;
- Award HE Level 3 (final year) credit; and
- Be sufficiently flexible to cope with the diversity of placement experience.
We wanted whatever system we produced to be based on accepted practice. We went back to first principles and the generic criteria for awarding credit for taught modules, namely:

- Credit value (10, 20, etc.);
- Notional learning time (with 1 credit equivalent to 10 notional learning hours);
- Learning objectives or outcomes;
- Level of learning (credit-level descriptors defining the expectations required of students at each level of their learning, e.g. SEEC level descriptors); and
- Assessments providing evidence that the learning objectives had been met satisfactorily.

The pedagogic system we developed to accredit workplace learning reflected these criteria. Any identified task was described in terms of:

- A title;
- A brief description;
- Learning outcomes (LOs);
- Generic/transferable skills;
- Specific skills;
- Justification of level of learning (using level descriptors); and
- Assessments or evidence that the LOs are met.

This format is essentially a module description, so students are effectively required to write their own individual module. The generic structure within this approach makes it suitable for workplace learning in degree programmes of differing disciplines, not just science.

**Administrative and pedagogic challenges**

In theory, this scheme appeared workable but there were a number of challenges to implementing such an approach:

- Each student would have individual Learning Agreements, tasks and evidence due to the unique nature of the placement;
- VTs needed a clear and simple communication channel established between the two geographically-separated, stakeholders to monitor students; ideally, this would also include the work supervisor;
- Communication via the postal system was seen to be slow, time-consuming and administratively cumbersome. Although email addressed the issue of speed, difficulties in organising and administering the placement module via this method remained; and
- How could we expect students successfully to take an active part in the formulation and justification of learning at L3 when they had only experienced L2?

In our approach, the student, through negotiation with the work supervisor and academic tutor, sets the learning outcomes and produces the evidence used to assess their attainment. This reflects the paradigm shift from the traditional role of the learner as passive recipient to one where the learner takes active responsibility for, and ownership of, the learning objectives. But how could this process be managed?

**The IT solution**

Task-orientated learning is best captured in a portfolio. However, such an individual, detailed approach to the assessment of work experience could incur a significant administrative overhead. Modelling placements in terms of the ‘modular’ metaphor described earlier makes their detailed description ideally suited to a database solution and, furthermore, managing this detail via the Internet could address the problem of geographic separation. Therefore, we developed a novel electronic-portfolio (e-portofolio) system, called Profile, to deliver this ‘modular’ approach to the recording and assessment of placement learning. Each student was given access to a secure e-portfolio within which he/she completed web-forms in order to develop and describe his/her unique learning agreement, as well as web-forms to define selected work activities in terms of the criteria for academic credit; to support assessment, evidence of learning could also be uploaded.

**Different user roles**

The student, being the main user, was considered as the owner of his/her portfolio. Certain other people could also gain access to the portfolio at the invitation
of the student, the two main ones being the work supervisor and academic tutor; these people had separate logins and could view the material in the portfolio and communicate with the student, providing ongoing feedback. Users with these roles could also ‘sign off’ work electronically (as described below). The involvement of the other stakeholders in this way allowed students’ learning to be both monitored and modified to help them reach their agreed learning goals. This combination of remote tracking and feedback proved ideal for students on placements that were both diverse and dispersed.

Within Profile, a communication tool allowed messages to be posted so that all stakeholders in any particular placement could see the questions posed and the suggestions made.

**Security**

To ensure that the work being reported by the student was indeed his/hers, a sign-off facility was incorporated whereby the work supervisor confirmed the authorship and standard of the student’s work. The VT also signed-off to confirm that the work had met academic requirements. To accommodate the sign-off facility, we produced a novel system whereby on the same form different form elements could be restricted to different types of users. For instance, for the majority of forms, the items on the form were restricted to the student to complete except for sign-off checkboxes used solely by the work-supervisor and tutor. This novel approach permitted the natural simulation over the Internet of familiar, paper-based processes involving forms.

**Flexibility and devolved management**

The system features devolved management in that appointed administrators can set up their own independent e-portfolio areas for their students, and contain their own custom web-forms and standard web pages designed to meet their own particular needs. The system replicates generic features of paper-based administrative systems:

- **Distribution.** A web-form can be ‘released’ to a particular type of user.
- **Help.** Standard web pages can be delivered to assist users.
- **Sub-sections.** Parts of a web-form can be reserved for filling in by other users.

**Attachments.** Uploaded files can be ‘electronically stapled’ to a web-form.

**Hand-in.** Web-forms can be electronically ‘signed off’ which locks their content.

**Profile e-portfolio forms**

The homepage http://www.profile.ac.uk serves as the login page to the e-portfolios and contains a few links to take visitors to explanatory web pages.

**For users of the system forms come in 2 categories**

The Learning Agreement (LA) web-form allows the student to lay out his/her learning during the placement period. The activities during placement are described in terms of tasks, with each task representing a learning opportunity. For science students, typical tasks may involve: learning a particular laboratory technique or procedure; data analysis or synthesis; formal presentations and report writing. The LA web-form consists of several sections: student id field; list of tasks; task deadlines; sign off and submit (which saves any valid changes).

The Task web-form is used to document the individual tasks contained in the LA; one form per individual task. Like the LA, the Task web-form consists of several sections which are again separated into smaller sections. Whereas there is only one instance of a LA, the Task web-form was made ‘clonable’ in that students could make as many copies of this form as required. As with the LA there is a student id field; list of tasks; task deadlines; sign off and submit (which saves any valid changes).

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The portfolio forms part of the assessment for awarding academic credit at L3. The students, therefore, are required to justify individual tasks at this level. They are assisted in this by the ‘Criteria for Level 3’ section on the web-form. Seven areas are covered: Knowledge and understanding; Ethical issues; Analysis; Synthesis; Evaluation; Application and Autonomy in skill use. Again for each category, an explanation is provided as well as a text area to be completed by the student explaining how the task is justified.

Tips/things to look out for

- Don’t be put off by negative comments by colleagues;
- Use criticisms to strengthen your case;
- Look to outside your immediate situation to see if your idea can be applied elsewhere. Quite often when others take up your ideas, closer colleagues will feel left out; and
- Bring detractors on-board to help you develop ideas.

What problems/issues have arisen?

- Workload issues; and
- Sustainability.

Does it work?

Yes. Uptake amongst colleagues across the HE sector is very high. The strengths in the system include: flexibility, generic, sharing good practice, setting up a community, no bottle-necks, it is free: under the terms of FDTL4 the system is offered free to the HE sector.

Further developments

With the rise in number of people adopting the system we need to track client requirements and the progress of the work. We are developing a Profile Incubator to assist interested parties in producing their materials and realms.

Generic nature of Profile e-portfolio

The simple, ‘Google-esque’, front page (Figure 1) masks the tremendous capabilities of the Profile system which allows users to customise web-forms to meet their own needs. From its original aim of offering an e-portfolio, the functionality has increased to provide users with a highly customisable and flexible knowledge management system used for work-based learning, PDP, CPD and managing administrative tasks such as ethics, health and safety and other governance matters.

If you wish to use Profile, please contact: profile@uwe.ac.uk

Figure 1. Profile front page
Using frequent computer-based assessment to ‘set the pace’ in a first-year bioscience module
Richard C. Rayne and Glenn K. Baggott

The problem and the context

All of our 4-year BSc programmes in biological sciences (and related subject areas) at Birkbeck are offered solely by part-time study in the evening to mature students. Most of our students are in full-time employment and many have families; moreover, many are returning to education after a significant break. For such students, time is an especially precious commodity and it is essential for them to settle into a study routine that is efficient and effective. We have observed that for many of our students, particularly those in their first year, establishing such a routine represents a major challenge. Although we cannot speak from experience on the issue, colleagues who teach elsewhere report that many ‘ordinary’ (i.e. ca. 18 years-old, full-time) first-year students will find establishing a study routine similarly challenging!

As an attempt to ameliorate this problem, in 2001 we launched a new first-year module, Molecular Cell Biology (MCB), designed around an assessment system that aims to dictate a steady pace of study and at the same time to provide opportunities for focused revision over the ca. 20 weeks during which the class is constituted (i.e. from the start of the module until the final exam). The central element addressing these aims of our assessment regime is a series of computer-based assessments (CBA) that will be described in more detail in the next section.

MCB is valued at 0.5 course units (cu); 10.5 cu are the minimum required for a BSc in our 4-year, part-time programme. It is rated at Certificate Level in the FHEQ. The module is taught annually in the Spring Term to 1st-year students on BSc Biological Sciences, BSc Biomedicine, BSc Molecular Biology, BSc Biochemical Sciences, Foundation Degree (Science), and various named Certificate courses. There are usually about 60 students taking the module. MCB meets on 11 consecutive Thursday evenings (January to March) and on 3 further evenings over the first 5 weeks of Summer Term (April to July). MCB is obligatory for progression, but is 0-rated in the Schemes for BSc Honours; in other words, although a grade is awarded, the unit is effectively pass-fail.

Our solution

Most important in ‘setting the pace’ and in providing revision opportunities for students on the MCB module is a series of computer-based assessments (CBAs) given on Weeks 3, 6, and 11 of the 11-week term. Although it happens that we use TRIADS to author and deliver the tests, there is no reason why other assessment and delivery systems could not be used with equal effect. (For more information about TRIADS, see http://www.derby.ac.uk/ciad/).

A critical feature of our approach is that these CBAs are first encountered as summative tests, given in timetabled sessions. The fact that the tests are summative (each contributing 10% to the overall grade) gets students’ attention – this is the ‘stick’ that sets the pace! Holding the tests in timetabled sessions ensures that students undertake them with only the aids that we supply (e.g. codon tables, diagrams, etc., as required). We do not have enough workstations for all the students to take the tests simultaneously, so we hold test sessions in shifts. Time allowed on the respective tests in 2005 was 35 min (13 questions), 40 min (13 questions) and 45 min (11 questions), so up to 3 shifts are feasible within our 3 h evening time slot. Within a day or two of a test, we report to students their scores on individual items, and on the test as a whole, via WebCT mail.

Once completed for a grade in a timetabled class session, each CBA then becomes available for formative use via the Internet in two forms (these are the ‘carrots!’): a self-test reporting a score only, but no feedback, and as a revision instrument with feedback.

Case Study 6
Using frequent computer-based assessment to ‘set the pace’ in a first-year bioscience module

Having taken part in this module, students are expected to gain a secure knowledge of basic molecular genetic/biochemical processes (DNA replication, transcription, translation, chromosomal basis of inheritance) and an understanding of principles underlying key laboratory techniques in molecular biology (electrophoresis of DNA, Southern blotting, PCR). They must apply this knowledge and understanding by solving problems in the form of small ‘case studies’ involving human genetic diseases.
supplied following submission of each item. Students are encouraged to use the feedback tests to revisit items on which they scored badly in the corresponding summative test. The self-tests are intended primarily for revision prior to an end-of-module CBA (25% of the final grade) that reflects back on the course as a whole. An incentive to use these formative tests for revision (another ‘carrot’) is provided by the fact that approximately one third of the items on the final CBA are very similar to items that appeared on the 3 previous tests; another third the topics covered on the earlier tests, but the items approach the topics differently. (The remaining third, as implied, are new items, on topics not addressed in the earlier tests.) This construction has another benefit: it allows us to monitor students’ improvement (or not!) from earlier tests to the final exam by comparing scores on the corresponding items. We have found in several cases over the years that such analysis has given us clues that have helped us to improve our instructional approaches.

Further advice

Give clear guidance to the students. We also take pains to give explicit advice on how and what to study, particularly for the first two tests. This advice falls well short of revealing any of the test items (!), but we think an open, clear approach helps students of all abilities and backgrounds to reveal their potential and provides encouragement that builds confidence.

Ensure that students have had adequate prior experience of using the CBA system. This is achieved for MCB students, who will already have encountered 3 similar tests in a preceding module (in the Autumn Term) where the tests are easier and also much more ‘low stakes’ than in MCB. This prior experience helps to quell anxiety and ensures that students have no difficulty in dealing with the manipulation and navigation tasks that the tests require (e.g. dealing with question style behaviours, submission of answers and revisiting answered questions). Toward the same goal, the time limit on the first CBA in the module is deliberately generous; this again helps to reduce test anxiety and allows students time to get fully acquainted with the operation of the test without feeling rushed.

Consider carefully the test interface. In accordance with the aim of ensuring students are being tested by the items, not by the interface itself, we have also spent time working on the presentation of the items and on the design of the question shells. We feel the key here is to think about the usability of the test, as this will help all test-takers, but will be particularly critical for students who have problems with their mobility (e.g. mouse control) and/or eyesight (whether ‘ordinary’ poor eyesight or more serious impairments). A highly usable test will likewise be helpful to students with dyslexia. Above all, a consistent and clean interface with an organised and reasonably predictable layout is essential to meeting this goal. (For another aspect of this concern, see Issues of Item Presentation in the next section.)

For students having more serious disabilities, of course it may be necessary to provide an alternative assessment. (We have yet to encounter such a situation.) A question arises as to how one might create an alternative assessment of approximately equivalent difficulty and validity to the CBA that the majority of students will use. Here, we have no easy answer, but we can offer a suggestion regarding how to make a start. We have always taken care to prepare an inventory of our CBAs on an item-by-item basis with respect to the learning outcomes addressed and to the item’s place in a ‘learning taxonomy’ such as the well known taxonomies of Bloom et al., (1956) and Imrie (1995). (We have stuck with Imrie’s ReCAP taxonomy because it is simpler: Recall, Comprehension, Application, Problem Solving.) Two experts rate each item against criteria set forth for ReCAP and then meet to agree a rating. Having recorded such an inventory, we can then form a picture of the learning outcomes addressed and the level of learning reached by each item. Whilst we recognise that this may be a crude reckoning (the taxonomies themselves are in fact contentious), we are sure that such information would be better than none if we needed to author some kind of alternative test that would: (a) be fair to the student(s) and (b) would give the teacher a secure indication of the students’ achievement.

Delay the reporting of the test scores. Above it was mentioned that we set up our tests so they do not return an immediate score when the student finishes the test, but rather we compile the marks and send them out later (within a few days) by WebCT email. Although this reduces the immediacy of the feedback, we think this is a good policy for a number of reasons. First, we know all too well that test authors (ourselves in particular) are fallible and there is a possibility of a mistake in the weighting or scoring of a test item or items (yes, we have done this!). Having a look at the scores before releasing them allows for correction of such mistakes and of course this saves many
We should mention that our CBA set the pace in a first-year bioscience module. Using frequent computer-based assessment to converge on the same learning goals, we made sure that the different assessment methods, but also that attempts to ensure that the different assessment methods, was used to assess the learning outcomes in MCB, but other assessments in TRIADS CBA address a significant subset of the overall learning outcomes in MCB.

Don’t rely just on CBA! It should be noted that in TRIADS, tests offer one item at a time – there is no option to provide a huge scrollable ‘page’ whereby all the items reside somewhere above and/or below the one item presently in view. Once the test-taker reaches the end of the test, he/she is presented with a list of all items; any unanswered items are noted and any item can be revisited by clicking its name in the list.

In our ‘early days’ of using TRIADS CBA in MCB, we set up the tests to offer a sequential, one-way delivery of test items so that there was no opportunity to skip an item without submitting a response and no opportunity to go back to an earlier item until reaching the end of the test. The precise reasons underlying the decision to disallow the skip and go back features are beyond memory, but it was soon apparent that students hated being restricted to this format! On the basis of student feedback, we therefore changed the arrangement: the tests so that every item could be skipped without submitting an answer and, similarly, it became possible to go in reverse to reach an earlier item from any point in the test. An advantage of this mode of presentation is that test-takers can allocate their time more rationally. For example, it is possible to skip items that might take a long time to complete, meanwhile polish off a few ‘easy’ pickings and finally go back later to the ‘harder’ items. Interestingly, although this arrangement makes it possible to flip all the way through the test first – to get a look at all items before starting to answer any – we have never observed a single test-taker to approach a test in this way!

Issues of item presentation have been addressed in the literature; particularly pertinent is a report by Ricketts and Wilks (2002b). In their experience, offering a CBA with a long scrollable presentation negatively affected students’ performance. Students preferred and scored better on tests where items were offered one at a time. However, it was not mentioned in this paper whether or not test-takers were offered the opportunity to skip items or to return to previous items at any point in the test. In short, it is good to be aware that item presentation is a critical issue and that some fine-tuning in accord with student feedback and performance indicators is likely to be necessary.

Timing. Another key issue that we grapple with is “How much time should we give for completion of a summative test?” We cannot claim to have an easy answer for this. In early runs of some of the tests, we did find that substantial numbers of test-takers were

Troubleshooting

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failing to reach the last 2 or 3 items on a test. (In which case, we moderated the marks to discount the few items that no one had attempted; more on this point is found above in ‘Further Advice’). Certainly, we have improved our estimates over the years as we have gained a sense of how long particular sorts of tasks are likely to take for our students. Given that only experience can enable a reasonable reckoning, we advocate tests that are unlikely to put the students under severe time pressure and suggest that teachers remain open to moderation of grades for tests that have had only limited field testing.

Open or closed book? In the first three years of using this approach, all the tests – except the final test – were open book. Students could use whatever aids they desired, so long as they did not confer with others. We thought this might be a fair compromise given the frequency of the tests; students would still have to know the material rather well, but could look up the odd fact that was beyond their immediate recall. We abandoned this practice primarily on the basis of student feedback: in short, students felt using notes was more of a distraction than a help! Even when this practice was permitted, we observed that very few students relied much on their notes when taking the tests – the time allowed to complete the test was normally too short for extensive consultation of notes, anyway. Consequently, since employing a ‘closed book’ rule, we have not seen a drop in mean scores.

**Does it work?**

In each of the 5 years in which the MCB module has run, we have made use of our standard module evaluation questionnaires and in some years have augmented these with additional questions and/or bespoke questionnaires. These routine evaluations of student attitudes to the CBA, and to the MCB module as a whole, are invariably positive (often enthusiastically so) showing that students believe in the approach. Over 2003-2004 and 2004-2005, we undertook additional surveys of the students using the Study Process Questionnaire (SPQ; Biggs et al., 2001) and the Assessment Experience Questionnaire (AEQ; Gibbs and Simpson, 2003). Our analysis of student responses to these instruments was part of a collaboration between the Formative Assessment in Science Teaching (FAST) project and the OnLine Assessment and Feedback (OLAAF) project. Detailed results from this work will be reported elsewhere (consult the OLAFF web site, listed at the end of this case study). In short, the results from the SPQ and AEQ indicated that our students were motivated to use a deep approach in their study and that the assessment regime that we have constructed encouraged and supported the ‘steady study pace’ that we hoped students would adopt.

Another interesting effect of the frequent CBA approach has been the added benefit of the formative tests for students whose first language is not English (Baggott and Rayne, 2001). Typically 15 to 40% of students from a given cohort on our bioscience programmes have a first language other than English. It is quite common to find such students in the computer labs perusing a formative TRIADS test with a copy of a Language X – English dictionary in hand! Such students report that the ability to revise directly from these feedback-containing tests is most helpful. It is our opinion that we get a better picture of such students’ abilities from the CBA results, given that they normally struggle to construct fully fluent written exam answers, especially in their early years of study.

We have also reported elsewhere on our analysis of the MCB module; see for example Rayne and Baggott (2004) and the materials (e.g. conference papers and presentations) on the OLAAF web site: http://www.bbk.ac.uk/olaaf

The FAST project web site may also be of interest http://www.open.ac.uk/science/fdtl/

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