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Engaging Our Community

The Centre for Bioscience has a very impressive track record of providing valuable resources and facilitating a wide range of initiatives in higher education. The departing co-directors, Ian Hughes and Ed Wood, along with all of the others associated with the Centre, are to be congratulated for their many achievements over the last seven years. I am, of course, enthusiastic about promoting and developing current programmes but at this point a new director might reasonably be expected to identify issues of high priority that should be addressed in the near future. Here are a few thoughts and ideas.

Colleagues will, I am sure, agree that we must more effectively engage our students in the educational process by encouraging them to think for themselves and actively learn about their chosen subject. In this regard I believe we must place strong emphasis on the development of students' problem-solving skills. During 2008 we plan to hold a professional development event that will focus on the teaching and development of these skills. A further initiative might be the construction of an interactive problem-solving website. If there is sufficient support from colleagues, the website would feature materials submitted from a wide range of UK HE institutions. Crucially, a detailed explanation of the solution to each problem would be provided. This high quality feedback would ensure that students extract maximum benefit from these exercises.

As scientists we generally encourage our students to find the single correct answer to a problem by following a logical train of thought. This is fine and, indeed, highly desirable up to a point. Unfortunately, however, we do little to encourage alternative, imaginative and truly creative approaches to problem-solving. In my view we fail to reach anything like the true creative potential of our students and I feel we should do much more to promote creative skills in bioscientists. This is a theme I would like to return to in future issues of the *Bulletin* and at Centre for Bioscience events.

Academics working in UK HEIs often express concern about the growing divide between research and teaching activities in our universities. I would like to propose a research-led teaching initiative that would ensure wide dissemination of cutting edge developments in the biosciences across all UK HEIs. This 'National Seminar Programme' would involve the production of a series of high quality recordings of talks given by leading researchers. Each recording would be accompanied by additional information about the work/publications of the seminar speaker along with exercises that encourage students to find out more about the science underlying the presentation. The key point is that undergraduates, postgraduates, postdocs and academics in all HEIs would have access to the most recent developments in the biosciences.

Recently, the Centre has successfully organised events in support of pedagogical research in the biosciences. The Centre is keen to facilitate further events and generally raise the profile of pedagogical research in our subject area. In addition, where appropriate, we would like to participate in collaborative research with colleagues throughout the UK HE community.

We in the Centre for Bioscience are keen to ensure that all academics in the UK make full use of the excellent facilities we can provide. During the next few years I therefore look forward to meeting with colleagues from as many institutions as possible to ensure that they are fully aware of the activities of the Centre and that the Centre provides them with truly indispensable resources in support of their teaching and research.

I would be delighted to hear from you. Please let me know if you have any comments regarding the above, or would like to know more about the Centre's activities.

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Teaching Award

The Centre for Bioscience Teaching Award has been launched. See *www.bioscience.heacademy.ac.uk/funding/recognition/award.aspx*

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CENTRE FOR bioscience

2 | Successful Transition

There is little doubt that student transition from schools and colleges into HE is an important issue. In fact it is becoming ever more topical, linking as it does to a number of major national agendas. Economically the nation requires increasing numbers of high calibre graduates, with particular skills-sets, if it is to compete globally. There are also social justice imperatives, widening participation and community cohesion agendas that necessitate ensuring that students from all backgrounds are able to access and succeed in HE.

Particularly for students from social groups traditionally under-represented in HE, success will often hinge on getting the transition stage right. Without suggesting that students have no responsibility for their own transition through the stages, it is clear that many will need support from the institutions they are passing from and to. Successful transition for many will only really be achieved with much closer cooperation between the sectors – i.e. through schools, colleges and universities working together with students, pre-entry, to better prepare them for the challenges ahead. The Nuffield Review Higher Education Focus Groups Preliminary Report (*www.nuffield14-19review.org.uk/files/news53-2.pdf*) identified some particular shortcomings or skills gaps amongst students arriving into HE. According to HEIs surveyed, students arriving from schools and colleges are unprepared for, or weak at, writing (especially extended essays), thinking independently, reading critically, basic numeracy and basic literacy.

Schools must, perhaps more than ever before, accept that they are ultimately responsible for equipping their students to progress successfully onto the next stage(s) of their lives. That is surely the primary business of schools – i.e. moving young people successfully along onto appropriate pathways and preparing them to succeed and progress beyond the school gates.

Schools can't be expected to do all of this alone, however. Even within the existing curriculum constraints there is plenty of scope for HEIs to become more pro-active in helping to prepare students for higher-level studies. They can do this chiefly through engaging with schools and working much more closely with the prospective undergraduates therein. Indeed universities must do this if they are to survive as the sector becomes an ever more competitive marketplace. University departments cannot afford to sit back and wait for students to arrive through the door fully prepared and ready to succeed.

Whilst there is certainly plenty still to do for all of us across the sectors it would be false to paint an unnecessarily gloomy picture. Indeed there are a number of positive things already happening and hopefully proliferating.

Positive Examples Across the Sector

- For many the latest 14-19 reforms appear to at least be attempting to address the skills needs of HEIs and employers (*www.dcsf.gov.uk/14-19/*).
- In many instances, and particularly through the SSAT's, HEI affiliation programme (*www.schoolsnetwork.org.uk/affiliation/default.aspa*), academic staff in HEIs and schools are coming together to discuss curriculum issues. As it progresses this will enable staff from both sectors to better prepare and/or receive students at the transition point.
- Aimhigher (*www.aimhigher.ac.uk/home/index.cfm*) is a high profile and well documented initiative that does much to bring schools into increased contact with HE. It has the potential to be used as the vehicle for a much deeper focus on transition and skills issues in addition to the awareness and aspiration raising work it is currently renowned for.
- Many schools are focussing on "out-of-hours" enrichment activities that free students of the shackles of the curriculum and the exam, and put them at greater liberty to explore subjects and particular topics in their own way – in other words they learn independently. Such activities also develop both depth and breadth of knowledge complementing the learning in the curriculum. HEIs should perhaps seek to involve themselves in these programmes wherever possible. e.g. A number of activities under the new Young, Gifted and Talented provision (*ygt.dcsf.gov.uk/HomePage.aspx?stakeholder=3*).
- There are a number of instances where school/HE transition is being assisted through projects offering students the opportunity to learn school curriculum topics at a university, in the HE style, and with access to undergraduate role models. These types of input acknowledge the pressure on schools to guide students through exams but also allow some further exploration of selected subjects and offer a different learning style and environment which helps to familiarise students with the differences in teaching and learning in HE compared to that in school. e.g. Slough Grammar School/Brunel University partnership. Contact SGS for details (*www.sloughgrammar.berks.sch.uk/contact-us.aspx).*
- Higher Education Modules in Schools (HEMiS) projects are enabling schools, through HE partnerships, to offer sixth formers the opportunity to study accredited HE short courses alongside A/AS levels. Whilst a challenging addition to student workloads these courses have been providing participants with the opportunity to develop broader and deeper understanding of chosen subjects. Not only this, but the courses require independent learning and research and offer genuine pre-entry experience of HE study (*www.open.ac.uk/yass/*).
- The SSAT's (*www.schoolsnetwork.org.uk*) role in supporting transition: depending on the school they go to, there is currently a huge variation in the levels of support that students might receive in relation to progressing into HE. This support ranges from very good down to virtually zero. The SSAT is committed to addressing that and to creating a much more level playing field for all students regardless of the school they might attend. For more details of this work please visit the HE section of our website (*www.schoolsnetwork.org.uk/community/highereducationinstitutions/default.aspa*).

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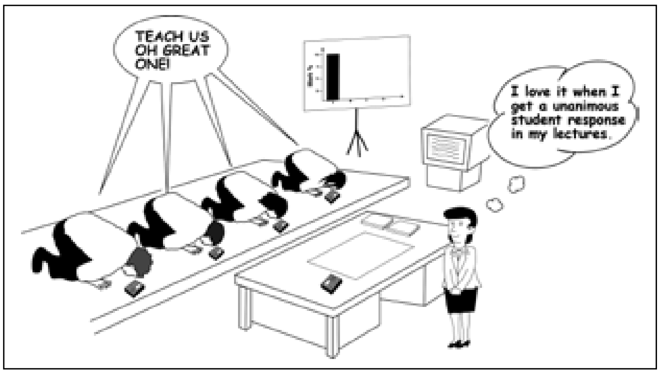
Preparing to Teach – Don't Forget The Student Response System

Student Response Systems (SRSs) are rapidly becoming an adopted technology to enhance Higher Education teaching. In a nutshell, this innovative teaching technology involves students responding to a question in class asked by the lecturer. Students answer the question by using a small handheld key pad, rather like a TV remote control. SRS software then displays the almost instantaneous results back to the class in graphical form. Just think of "ask the audience" in the popular TV show "Who Wants to Be a Millionaire?" to picture the format. This article aims to extol the versatility of an SRS to academic novices and provide experienced academics with a few new student response system ideas to enhance their interactive teaching.



Traditional lectures typically involve a one-way transfer of information from the lecturer to the students. However, have you ever wondered if the class really understood the material that you have just covered? An SRS is an ideal tool to instantly assess students' understanding of the subject matter. Different questioning strategies can be used, such as questions with an incorrect element to identify, or those with numerical or problem-solving aspects, as well as standard factual recall questions; sometimes provoking further and more thoughtful class discussions. Occasionally, you might be surprised or even frustrated by the displayed class results. However, you are likely to have a considerably livelier and more interesting teaching session than you have ever had before. An SRS is also useful for promoting peer learning, as you can encourage students to discuss or debate in order to convince each other of the correct answer. Pre-discussion and post-discussion question results often create memorable teaching sessions and help to engage students.

Another useful way to determine how well your students are understanding material being presented to them is to assess students' knowledge pre and post lecture. The following question was asked of 400 Level 1 biology students with heterogeneous academic backgrounds before an introductory microbiology lecture at the start of the first semester. "Which one of the following is NOT a method of horizontal gene transfer in bacteria? A. Binary Fission; B. Conjugation; C. Transduction; D. Transformation." Before the lecture 60% of the class answered the question correctly, at this stage the correct answer was not provided. After the lecture 90% of the class answered the same question correctly. Whether the lecture enabled students to acquire new information or acted as an *aide memoire* for previously learnt facts is debatable, but the increase in correct responses gives a snapshot of class knowledge which can be built on in future lectures.

The use of an SRS can also encourage a higher level of student engagement with any video clips and animations that you embed in your lectures. For example, consider using a series of related questions in order to gauge students' comprehension of presented material. The Inner Life of the Cell produced by Harvard University (*www.aimediaserver.com/studiodaily/harvard/harvard.swf*) is an incredible five minute animation and should be mandatory viewing for all new undergraduate biology students. This animation was presented to 300 Level 1 cell biology students and an SRS was then used to pose questions based on the animation to provide an interactive session.

SRS can also be used for class surveys. A recent pilot project undertaken by Aberdeen University to promote Personal Development Planning (PDP) used an SRS to help introduce the concept of PDP and promote the many benefits of PDP to Level 1 biology students. The introductory PDP session commenced with a survey question "Before today have you encountered the term personal development planning?" Only 25% of the 300 polled students were actually familiar with the concept of PDP. Survey results were therefore extremely useful to help steer the delivery of the introductory PDP session and maintain the students' attention span, by bringing this dry topic to life.

An SRS is not only a powerful tool to obtain individual responses from hundreds of students at once in large classes but it can also help you monitor student attendance. However, do bear in mind that students tend to volunteer answers and opinions in a large class without fear of intimidation or embarrassment if the response system remains anonymous.

Finally, what do Aberdeen students think? End-of-course evaluations indicate a high level of student satisfaction with using an SRS as a learning and feedback tool. So, go on – use a student response system, use it often and in different ways to engage your students and keep their attention.

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Amendment

Full credit should also go to authors Joyce Overfield, Carol Ainley, and Alan Fielding at the School of Biology, Chemistry and Health Science, Manchester Metropolitan University for their contribution to the article 'A departmental policy for providing feedback to students' which appeared in the Autumn 2007 (no. 22) edition of the *Bulletin*.

4 | 1st Year Bioscience Lab Classes

It is recognised there is a shortage of bioscience graduates with laboratory skills and aptitudes. It was therefore thought worthwhile to discover students' views on the laboratory work they undertook in year 1 of bioscience courses so that changes could be made which might improve the students' view of laboratory work and feed through to later years a student body more interested and involved in laboratory work. In conjunction with AstraZeneca and the British Pharmacological Society, the Centre for Bioscience has surveyed 1st year bioscience students about their views on laboratory classes they were undertaking. Returns from 695 students (70%) in 9 UK universities were obtained in February-April 2007. While this was a good response rate it must be borne in mind that an opinion expressed by say 40 students represents less than 5% of the returns.

Results

Most students preferred the laboratory classes they had experienced at school to those they were experiencing at university ('Very good explanations and demonstrations given. Much more help given. A lot more teaching around the subject before the practical and told exactly what to do and why.').

Although student views were varied, there was clear identification of the best features of university laboratory classes as:

- learning new skills and using new equipment;
- the opportunity for social interaction with students and teachers;
- the ability of practicals to illustrate material given in lectures;
- the acquisition of new knowledge through practical classes; and
- high interest value of practicals.

Students identified the worst features of university laboratory classes as the:

- length of practicals – 'too long';
- organisation – poor, 'always waiting about for stuff';
- write-ups – 'too time-consuming, too long';
- nature of practicals – tedious, boring, repetitive; and
- staff contribution – inappropriate and variable, 'staff were rude if you didn't understand something'.

Discussion

Overall the data raises concerns that for many students the experience of laboratory work in the first year is not good and there are some themes which suggest ways forward.

Effectiveness and consistency of staff. It is appropriate to ensure all staff teaching the practicals are competent, approachable, fully informed and able to <u>teach</u>, not just <u>run</u> the practical.

Socialisation. The importance students place on knowing students and teachers in their class and forming friendship networks should be recognised and enabled.

Attitudes. Students find 1st year practicals long, boring and tedious. While appreciating that teaching skills are important (and valued by students) there should be an additional explicit objective for 1st year practicals – enthusing and interesting the students in laboratory work by ensuring they experience the excitement of discovery.

Organisation in practicals. The students' emphasise 'waiting around' for one thing or another. In part this may be an issue of equipment shared between too many students.

Reliance on lab equipment. We need to address the heavy emphasis students place on equipment (complicated, advanced, better) and get across that equipment is not an end in itself. Repeatedly, students emphasised their interest in equipment, never what it enabled them to do.

Environment. The issue of students enjoying practicals at school because they felt more relaxed. This may come from the greater familiarity they have with the school environment. At the first practical, everything and everybody is new to students at university.

Transition. The magnitude of the transition which students are undergoing from school to university needs to be recognised. As one student said 'it felt like I'd been thrown in at the deep end and without a float'. We should consider starting in a very supported environment and allow students to make the necessary transitions over a set of laboratory classes during semester 1.

Diversity. We must recognise that 50% of students taking biosciences courses may take employment outside bioscience, let alone involving laboratory work, and courses at university need to provide a good and appropriate experience for all students.

Two interesting suggestions emerged which might be areas for development: 'students should be able to do a lab again until they are satisfied with it', 'it would be useful to have a take away example of a perfect experiment for revision purposes'

Finally, reporting some very positive comments made: 'on the whole I love them and find them really useful and always fun to do', 'brilliant lab classes with helpful tutors and great instructions. I've learned a lot and enjoyed so much. Thanks.'

Conclusions

While most students in the biosciences progress to careers not involving practical work, some will become involved in practical studies in education, research and industry. The early experience in university is likely to have profound effects on whether some students see practical science as an attractive and exciting career choice. The survey results suggest ways in which 1st year bioscience practical classes could be more engaging and stimulating.

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Enterprise Developing Skills and Attitudes

The major breakthroughs in recombinant DNA and related technologies that have occurred during the last 30 years have resulted in a massive expansion in commercial bioscience. Indeed, the biotechnology sector is currently estimated to contribute between US$100 – 150Bn to the global economy each year. Universities have made a major contribution to the growth and development of the bioscience industry and, at the same time, these institutions have acquired a new set of obligations: they must ensure that their students and staff are fully equipped to influence, and participate in, the exciting new developments that will undoubtedly occur during the next few decades.

Universities in the UK are responding to the challenges associated with commercialisation of bioscience by embedding enterprise learning in degree programmes. Within the Faculty of Biological Sciences at the University of Leeds, we focused initially on the development of teaching resources that promote a wide range of so-called enterprise skills in students enrolled on a new, broad-based Bioscience degree programme (approximately 30 students enrolled per annum). As students progressed from Levels 1 – 3, they encountered increasingly challenging exercises designed to ensure their engagement and participation. At Level 1, we captured students' interest in a range of exercises based on subjects of immediate topical interest such as GM crops, MRSA, nanotechnology and biosensors. Each exercise involved the development of readily transferable, enterprise-related skills including creative thinking, communication/presentation, business planning, information gathering, negotiation, networking, team work, time management and ethical awareness. We adopted a similar approach at Level 2 where we placed strong emphasis on consideration of ethical issues. This was achieved readily in Leeds through our collaborations with colleagues from the IDEA (Interdisciplinary Ethics Applied) CETL. Finally, at Level 3, students really got to grips with the enterprise agenda as they worked towards the creation of a 'virtual business', attended sessions run by experts in intellectual property protection, business planning and negotiation, and interacted with software designed to promote their creative potential. The approach worked well and, as our programmes evolve, we plan to make the enterprise teaching material available to all students enrolled on Faculty degree programmes (approx. 600 per annum).

One of the most exciting aspects of the enterprise agenda is the opportunity to promote creativity in our students. Young children are often highly creative. Unfortunately, during school years and the early years of university, we do very little to encourage creativity in scientists. Indeed, biologists and other science students are often not expected to be truly creative until they engage with final year project work at university. We are trying to help students achieve their creative potential, and develop innovative approaches to problem-solving, from Level 1 of degree studies. Central to our efforts in this area has been the creation of the website 'Creativity and Research-led Teaching' that promotes creative approaches to problem-solving, in individuals and groups, at the same time introducing the students to cutting edge developments in research at the University of Leeds. The website is used extensively during the Level 3 module 'Enterprise for Life Scientists' and is directly available to students and academics outside Leeds (*www.fbs.leeds.ac.uk/creativity*; Figure 1).

A key element of our approach to enterprise learning and teaching is the inclusion, in module manuals, of an 'enterprise learning log' in which students record progress. The log helps to impress upon students the value of the sessions and encourages them to reflect upon the skills they have acquired. When students realise that engagement with the enterprise agenda will help them build an impressive CV that is likely to improve their employment prospects, they often show a great deal of enthusiasm for what we are trying to do. Persuading staff of the value of enterprise can prove more of a challenge. The best approach is to explain to colleagues that engagement with enterprise issues will help students become creative problem solvers and communicative team workers. As a result academic staff will teach more capable and employable students who are likely to be much more effective in the research laboratory and elsewhere. We often find we are pushing at an open door!

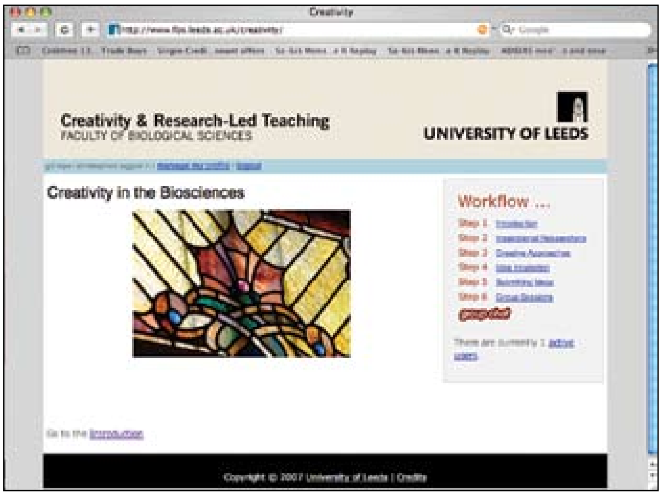

Figure 1: Creativity and Research-Led Teaching website for bioscientists.

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6 | Microbiology and Art

Over the past few years, I have given a lecture illustrating many of the links between microbiology and art to first year biology undergraduates. Initially, the lecture formed part of a general module, Frontiers in Biology (Verran, 2007) but the course review resulted in the establishment of a Microbiology module (2006-7), into which the topic fitted well. The lecture is accompanied by an assignment, selected by the students from six choices offered by the module, which includes more traditional formats: two PowerPoint slides describing a microorganism 'of current importance' – or a website evaluation. For the art assignment, students have the opportunity to produce, alone or in groups, an item to illustrate some link between art and microbiology – hopefully inspired by the lecture! There is no upper limit to the number of students who can take this option. Ideas are discussed during a tutorial, and assessment criteria are negotiated between myself and the student(s). The outcomes are diverse, often creative and inspiring, and several have been used to illustrate this article.

The topics covered in the lecture, entitled 'Microbiology and Art: an unusual combination?' are:

Deterioration of Art

Microbial-induced spoilage of art and heritage material is perhaps the most obvious link between the subjects, but I also describe aspects of prevention and control of such deterioration, and give examples of microbiologically-induced remediation. Students found this example of applied microbiology novel, and several opted to do assignment work on, for example, spoilage of film, ancient Egyptian art or stone monuments. Their work was primarily presented in poster format, but one student produced a photographic record of 'biofilms around Manchester', discussing the subject with a human geographer with an interest in ruins and decay (Edensor, 2005).

Beauty of Microorganisms

The excitement generated when a 'good' specimen is found 'down the microscope' can be infectious: it is not only the success of finding the microorganism – sometimes they look really nice! Beautiful images are common in textbooks and in lecture presentations. Images can be enhanced and modified, and find a diverse range of uses: calendars (eg *www.veeco.com*), websites, graphic art posters, clothing (*www.iawareables.com*), toys (*www.giantmicrobes.com*) collage and so on. Student products included three-dimensional models (Figure 1); customised lab coats; silk paintings; designer jewellery; toy characters, and so on.

Microorganisms in Art

Suprisingly, microorganisms themselves may provide material as well as inspiration for art: pigmented bacteria can be used to 'paint' images on agar plates (Park, 2007); pictures made on microscope slides from diatoms or fungi can be purchased for educational use *(www.diatoms.co.uk; www.hps.cam.ac.uk/whipple/explore/models/glassfungi; www.britmycolsoc.org.uk/resources.asp*). During the assignment, some students produced 3-D models of viruses; another built a phage, photographed it and created an Andy Warhol-inspired photo-montage.

Microbiologists and Artists

The consequences of bacterial and viral diseases, rather than the microorganisms themselves, provide ideal subjects for visualising through art the destruction wreaked by plagues through history (e.g. *www.wellcome.ac.uk*), and upon individuals (e.g. The Inheritance by Edvard Munch). Students created PowerPoint presentations outlining the influence of plague on contemporary art; produced conceptual images using FISH technology; painted an interpretation of the development of science (Figure 2); produced a collage in 1930s style of the importance of tuberculosis in literature; designed panels for the AIDS quilt; profiled artists who interpret science through the medium of paint; produced an influenza teaching package (Figure 3), comprising models and a PowerPoint presentation. 'Life on a toilet seat' presented a range of suitably placed images and poems (Figure 4). One group worked with an artist, Lynne Setterington, producing in parallel with her work on recycling plastic bags, a scientific poster outlining aspects of plastic biodegradation – or lack of.

Evaluation

This academic session (2007-8) marks the fourth iteration of the assignment. From a small initial group in the first year (approximately 20 students and 12 products), to over 50 in the second year, a more modest 10, and now almost 30, the feedback from students has been very positive. Since they are self-selecting, there is no sense of inadequacy, and there is a significant enthusiasm to employ talents other than those perceived as 'scientific'. This year I have been promised a play and a rap!

Assessment for the Microbiology module is '100% coursework', and comprises laboratory work (50%), two multiple choice tests (30%), and the assignment (20%). Marks awarded for the art assignment have hitherto been generally high, provided that the students adhered to the negotiated assessment criteria. For example, in 2005-6, from 50 students, 24 'products' were awarded the following marks: 90 – 100%, 4 products; 80 – 89%, 3 products; 70 – 79%, 5 products; 60 – 69%, 7 products; 50 – 59%, 5 products.

Added Value

It was also important that my office did not become a repository for an increasing pile of dusty posters or models. Thus the students' art for the first two years was displayed at an event for which industrial sponsorship (Leica Microsystems), including prizes, was forthcoming. One of the student montages was framed (funded by the sponsor) and is displayed in the School reception area (Figure 5); others have been used as teaching aids. Particularly satisfying is the number of students who ask for their work to be returned for them to use as home decoration. In 2006-7, four pieces, duly acknowledged, were chosen as illustrations in the Society for Applied Microbiology 2008 calendar (*www.sfam.org.uk*).

Figure 1: Papier mache models (on spiral balloons) of Vibrio harveyi, demonstrating quorum sensing (bioluminescence of cells in group, not of single cell). Models accompanied by PowerPoint presentation (Rehana Akhtar and Stacey Goulden). Photo copyright sfam 2007.

Microbiology and...

It rapidly becomes apparent that the combination of microbiology with other subjects such as literature, where the impact of disease on the development of particular novels can be explored; or music, where composition or lyrics can assist in recall of complex terminology, is easily possible. Subjects such as history, geography, politics, economics are inevitably associated with the epidemiology and management of emerging and re-emerging disease - thus the assignment is sufficiently broad that it enables students, if they wish, to utilise additional skills and interests in combination with microbiology.

An awareness of the different interests and learning methods of students is important in providing an appropriate stimulating educational environment, particularly when the numbers of students is increasing, and their entry qualifications and abilities are more varied. Enabling the expression of creativity amongst first year science undergraduates has been a particularly rewarding experience.

Figure 2: Key moments in science (Matthew Lavin).

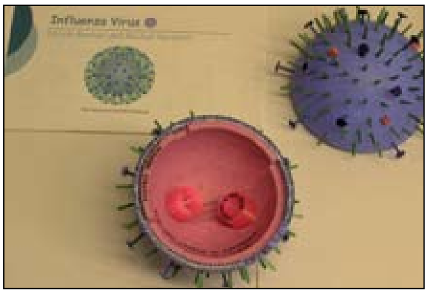

Figure 3: Model of influenza virus with accompanying PowerPoint presentation (Nicola Barker, Rachel Herstell).

Figure 4: Life on a toilet seat (Tina Booth).

Figure 5: Aspergillus. Silk paintings and other imagery (Natasha Khan).

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8 | Aquatic Ecosystem Simulator

Many concepts in population and community ecology cannot be investigated directly through experiment at undergraduate level due to obvious spatial and temporal constraints, hence these subjects are traditionally taught from a theoretical standpoint. Alternatively, through the use of appropriate computer simulations, the student is empowered to take an experimental approach to discover the beauty and complexity of the dynamics of ecological systems in what is, hopefully, a more engaging and effective way. For a simulation model to succeed as a teaching aid it must possess adequate realism and flexibility, combined with an acceptable user interface. Aquatic Ecosystem Simulator (AES) provides a flexible learning aid for experimental study in aquatic ecology, separate from the process of mathematical modeling. It simulates the physico-chemical and trophic dynamics of freshwater systems containing functional groups (guilds) of organisms forming planktonic and benthic food webs. The model is calibrated by default to emulate alternative scenarios (mesotrophic-temperate, eutrophic-temperate, hyper-eutrophic tropical, and oligotrophic-arctic systems), and a range of experiments can be performed by manipulating the realistic system variables (e.g. eutrophication, competitive exclusion, climate change, flood impact, and biomanipulation).

Over the course of some twenty years in the Biological Sciences degree schemes at Cardiff University, we have developed AES with the aim of motivating students and enriching their existing knowledge of ecology as well as developing generic skills (hypothesis testing, problem-solving, enquiry learning, and critical evaluation of quantitative data). In our experience, biology students lack interest in the mathematics underlying computer simulations of biological systems (Korfiatis *et al.*, 1999). To put forward theories and equations at the outset would serve to confuse rather than to illuminate. We use AES as a tool to promote understanding of ecological processes and the practicalities of research in the natural environment. Simulation challenges students to interpret large quantities of data, considerably more data than they could possibly generate by traditional practical work (laboratory or field). It shows the value of a computer model for demonstrating fundamental ecological concepts (biomass pyramids, food chain efficiency, competitive exclusion), and for predicting the impact of anthropogenic activities on a complex aquatic ecosystem (manipulation of trophic status, climate change, and trophic cascades). We have adopted a similar practical approach to teaching statistical analysis of biological data using a workbook which leads students through analysis and interpretation, without involving the underlying mathematics (Bowker & Randerson, 2007).

AES is operated by on-screen option buttons connected by a flow diagram to assist navigation. Instructions on how to perform hypothesis-driven experiments are presented in text boxes and help windows, so that a conventional handbook is not necessary. Simulation proceeds by numerical integration of 27 differential equations with respect to time. Values of state variables, driving variables, rate processes, and other simulated data at daily intervals for up to five years are output numerically in tables, and graphically as line-graphs, bar-charts, and pyramid-charts. Data can be saved as text files and Microsoft Excel spreadsheets for further analysis. Graphs and charts can be saved as bitmap files to be added to Microsoft Word documents. Photographs of typical ecosystems and organisms are included (in response to student demand). The equations and constants used in AES are well known (e.g. Pauly & Cristensen, 2002). AES is pre-calibrated with values of 121 parameters (36 fixed constants; 85 of which can be changed by the user). Randomness, associated with natural biological variation and analytical error is a primary characteristic of all biological data; AES includes an option for some parameters to vary randomly around deterministic values.

Students may use AES independently to pursue their own simulation experiments rather than following pre-assigned structured lesson plans (Feurzeig & Roberts 1999), but some preparation about the theory of ecological community structure and trophic dynamics is necessary. AES enables students to formulate and test their own hypotheses and to report results both as an oral presentation and conventional written report.

AES is clearly transferable to other courses and if anyone is interested in using it in their teaching get in touch with Peter Randerson. This was developed with financial support of HEA Centre for Bioscience, Teaching Development Fund. More information on AES including images of the user interface, full reference list and details of the food web can be found at *www.bioscience.heacademy.ac.uk/funding/currentprojects/randerson.aspx*

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Teaching Development Fund for HE in FE practitioners

The Centre for Bioscience is pleased to announce the availability of grants of up to £3,000 for members of our HE in FE bioscience community. This funding is offered to encourage the development, establishment or validation of innovative learning, teaching and assessment materials or methods. The deadline for applications is: **Wednesday 16th April 2008**. Further details: *www.bioscience.heacademy.ac.uk/funding/tdf/*

Interactive 3-D Models in Teaching

Structural biology is an essential component of current molecular bioscience teaching. However, it requires students to develop an understanding of 3-dimensional (3-D) structures that is difficult to acquire from conventional teaching methods using 2-dimensional images, in either books or lecture slides. As of November 2007, there are 47,283 crystal structures of biological molecules publicly available in the Protein Data Bank (*www.pdb.org*) as well as a number of open source tools available to render these structures into 3-D models which can be visualised on standard computer platforms. This provides a valuable opportunity for the development of new teaching approaches which enhance student learning and engagement.

In the Department of Plant Sciences at the University of Cambridge, we have used a 3-D molecular visualisation program called Jmol (*www.jmol.org*) in a virtual learning environment, as well as in lectures, to embed structural biology into plant science teaching.

What is Jmol?

Jmol is an interactive Java (*www.java.com*) applet which can be inserted into web pages to display chemical structures in 3-D (Figure 1). It has a wide range of rendering options, ranging from simple ball and stick representation to illustrating protein secondary structure elements. The displayed molecule can be rotated and zoomed to allow viewing from any angle. Control of rendering can be achieved in three different ways. First a pop-up menu can be used to select and render different parts of the molecule as well as to measure molecular distances. We have successfully utilised this interface to provide online teaching materials to a class of 360 students with a diverse range of computing skills. Secondly the applet can be controlled by buttons which call pre-defined scripts from a server. This approach can be very effective in online tutorials. Thirdly a command line interface provides an environment for teachers to develop scripts, as well as for advanced students with programming skills to develop their own web pages. Once familiar with its commands, custom scripts can thus be written to select and format individual atoms or amino acids to emphasise particular structural features.

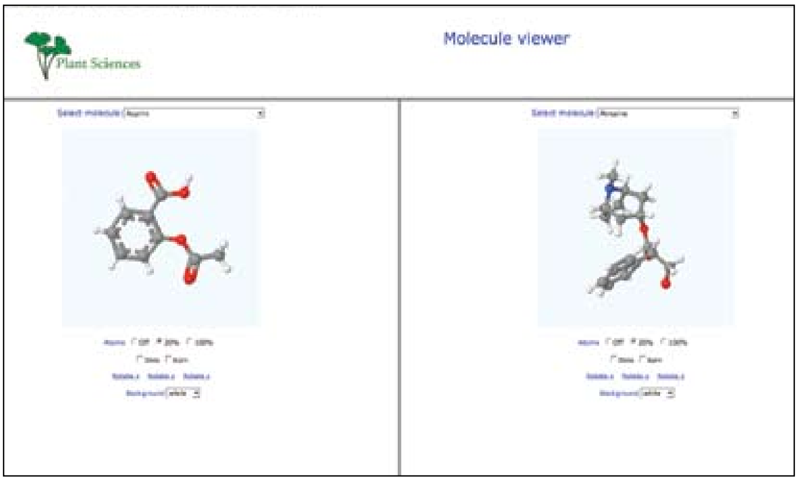

Figure 1: Example of the Jmol applet inserted into a webpage, allowing side-by-side comparison of small molecules.

Jmol is open-source software which automatically runs on both PC and MAC platforms with no additional configuration, apart from ensuring that the latest version of Java is installed. It can display molecules in a range of formats, including Elsevier MDL files and Protein Data Bank (PDB) files. A very wide range of molecule files are available in these formats - for proteins, the most comprehensive resource is the PDB.

Molecular Pedagogy

There are several ways in which Jmol can be used to enhance bioscience teaching. The simplest way might be to generate a molecular library, where students can explore a collection of 3-D structures related to a course and use pre-programmed buttons to enable a range of visualisation options (Figure 1 shows an example of a simple library). Alternatively online tutorials can be created which emphasise the role of particular molecules in a wider context. More advanced students might develop their own tutorials as part of a teaching program.

Because virtually all types of online learning resources are largely html-based, 3-D molecules can be embedded in a range of applications. For example, Wimba Create, formerly Course Genie, (*www.wimba.com/products/wimbacreate/*) a popular choice for creating online multiple choice questions, can be modified to include Jmol. Camtasia (*www.camtasiastudio.com*) allows narrated, live-screen capture including Jmol to be converted into Flash video explanations. Using a plug-in such as LiveWeb (*skp.mvps.org/liveweb.htm*), both online and off-line web pages can be accessed directly within PowerPoint slides to allow Jmol to be used in lectures. Once a basic platform has been put in place, many other resources are available (e.g. the molecule of the month at the PDB website).

Student feedback about learning resources utilising Jmol has been very positive. It is summed up by the comment from one student; "Best practical of term – very cool"!

Further Information

- The Plant Sciences Pedagogy Project: *www.tfln.org*
- For examples of Jmol tutorials developed by Plant Sciences: *www.tfln.org/projects*
- For more molecular visualisation resources: *www.umass.edu/microbio/chime/*

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10 | Changes to A-level Biology
(The Trilogy Concludes)

A-level Biology changes in 2008, as part of a fundamental review of secondary science that began in 2006 with new GCSEs for this cohort. This will ensure that compulsory science education equips all youngsters for citizenship as well as preparing future scientists for A-level and beyond. How Science Works will be more prominent at all levels.

Having explored the rationale behind the newly-accredited A-levels, and their common features (*Bulletin* 20 and 21), here I compare them. All comply with the Science A-level Criteria (*www.qca.org.uk/qca_4099.aspx*). There are six units, one internal assessment (including practical skills) and two external, in both years (AS and A2).

Specifications must: protect rigour; build on changes to GCSE science; emphasise How Science Works; present biology as accessible and relevant; develop skills, dispositions, knowledge and understanding; include contemporary contexts; balance plant, animal and micro-biology; and educate for sustainability.

Content

Sixty percent of the content is defined in this "core":

	AS	A2
Population	Biodiversity, classification, evolution	Ecosystems, including human influence
Organism	Exchange and Transport	Control systems (homeostasis, nerves, hormones)
Cell	Cell structure; cell cycle	Cellular control (genotype to phenotype, gene technology, speciation)
Molecular	Biological molecules; enzymes	Photosynthesis, respiration

The Awarding Bodies (ABs), namely AQA, Edexcel, OCR, and WJEC, have flexibility in content, approach and assessment.

The core for Biology (including Human Biology, offered by all except Edexcel) leaves scope for ABs to define the remaining 40%. Though some additional topics are common to several ABs, each specification has its own flavour. Options are prohibited, so additional content is dispersed throughout the core, and mandatory.

Specifications include topics as diverse as stem cell research; global warming; infection; exercise physiology; brain structure and development; haemoglobin biochemistry; courtship behaviour; genetic variation in bacteria; and uses of plant products.

Approach

Edexcel permits different approaches leading to the same assessments: a traditional concept-led route; and context-led topics (as in the current Salters Nuffield Biology). It will be fascinating to observe which becomes most popular, and why. Supporting both routes to common assessment seems a bold challenge.

For example, here are Edexcel's approaches to Unit 1, covering the same content:

Concept-led	Context-led
Carbohydrates, lipids, proteins; enzymes; membranes, passive and active transport; DNA, RNA; replication, protein synthesis; monohybrid inheritance, mutations; gene therapy, social and ethical issues	Lifestyle, health and risk discusses lifestyle choices for good health, considers ideas about correlation, causation and risk. Genes and health uses the context of cystic fibrosis. The potential of gene therapy is examined, and the social and ethical issues surrounding genetic screening discussed.

Assessment

The external assessments use conventional mixtures of shorter structured questions and longer questions. For example, AQA uses comprehensions; structured essays; data-handling; analysis & evaluation questions; and (for A2) a synoptic essay, as the formats for its longer questions. Such approaches allow ABs to assess aspects of How Science Works, to introduce 'stretch and challenge' (partly through the requirement for synoptic assessment in A2), and to credit English. The main variation between ABs arises in the two units of practical skills assessment. There is a move towards more controlled condition and reduction of the burden on teachers. Centres can choose between various approaches.

Implications for Lecturers

Schools are under huge pressure from curriculum change, causing some conservatism towards A-level change. Teachers value your moral support; if you could help with their professional development, drop me a line!

The student intake fresh from 2010 A-Levels will

- have studied a revised common core, with various additional topics;
- understand more How Science Works, but a bit less content; and
- be increasingly diverse in academic background.

Your expectations, perhaps your courses, may need to change accordingly: I leave that to your expertise!

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Engaging Bioscience Students with Chemistry using VLEs

Sound chemistry knowledge is necessary to understand key bioscience concepts. However, many students join the degree without an A-level in Chemistry. Moreover, the widening participation agenda means that the number of people entering HE from non-traditional backgrounds is rising. A weak chemistry background can make the first year at university difficult for both lecturer and students. Research suggests that careful curriculum planning can increase recruitment and retention of non-traditional students in the biosciences (Brandford-White, 2003). McClean *et al.*, (2006), have used a combination of traditional approaches (tutorials, printed handouts, etc.) and e-learning techniques (computer assessment) to provide chemistry support for bioscience students.

The aim of this project, funded by the Centre for Bioscience e-Learning Mini Projects, was to develop an online module covering a selection of general chemistry topics, which could be used to support first year bioscience and life science students. The module, aimed at students with little chemistry background, integrated theory, interactive exercises and formative tests. The topics developed were Atomic Structure, the Periodic Table, Chemical Bonding, Balancing Equations and Using Moles, Redox Chemistry, Units of Concentration, Acid/Base Chemistry, and Introduction to Organic Chemistry. Three additional folders were developed: Useful Information for Newcomers, Suggested Reading, and External Resources. Whenever possible, suitable e-resources developed by other practitioners were integrated, such as those available through Jorum *(www.jorum.ac.uk)*. Six new web applications were developed for this module (balancing chemical equations, balancing redox reactions and a set of periodic tables); these learning objects were posted on Jorum at the end of the project.

The Chemistry Resources module was deployed on Blackboard and made available to students enrolled in a Foundation year in Science; a total of 20 students took part in the project. Although the module was designed to be delivered completely online, references to it were integrated in the normal taught chemistry course, to encourage student usage and maximise integration with the taught curriculum. Student evaluation (gathered using questionnaires) was positive; students rated highly the existence of exercises, quizzes and tests. They also mentioned as a positive feature the existence of links to external resources ("you know the links you follow will be relevant and correct"). Student usage was monitored through the course log. The most popular month was November, with 16 students accessing the VLE module; the months with the lowest number of students (3 in each month) were October (the beginning of the academic year), and April (coinciding with the Easter break).

Other project partners were Dr Simon Clay (freelance software developer), Ms Glenis Lambert (Canterbury Christ Church University) and Dr Carlos Lodeiro (REQUIMTE, Department of Chemistry, New University of Lisbon, Portugal). Dr Nick Morris (University of Newcastle) acted as critical friend. We are also grateful to the Treaty of Windsor Anglo-Portuguese Joint Research Programme for funding visits between Canterbury Christ Church University and the New University of Lisbon, Portugal.

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Figure 1: Screenshot of the exercise Balancing Chemical Equations (now available in Jorum).

Bioscience Education E-Journal Volume 10

The articles below are available on our website at *www.bioscience.heacademy.ac.uk/journal/*

- Experience(s) in Creating Distance Learning Texts
- The Effectiveness of Lecture-integrated, Web-supported Case Studies in Large Group Teaching Dice and DNA
- Attitudes to the Uses of Animals in Higher Education: Has Anything Changed?
- Realising e-Learning Matters in a Bioscience Cohort
- Podcasting is Dead. Long live Video!

We also invite submissions for volume 11, see the website for further information.

12 | Enquiry-Based Learning – A Student View

During the summer of 2007 we were part of a group of seven undergraduate students from different disciplines selected to take part in a project based in the Learning and Teaching Centre (LTC) at The University of Glasgow. The project was led by Jane Pritchard and Bob Matthew of the LTC. The aims were to produce a guide and supplementary materials for students and staff promoting Enquiry Based Learning (EBL) (Phase 1) and to be involved in student-staff curriculum design that would introduce more EBL into courses at Glasgow University (Phase 2).

Upon embarking on Phase 1 of the project we didn't know each other and we had limited knowledge about EBL, but that was soon about to change. We spent the first week brain storming, completing a very important part of the EBL process in realising what we knew already and formulating central questions we had regarding EBL. The remaining weeks of the project continued with an EBL approach and we found ourselves carrying out the very topic we were investigating.

In the second week we visited the Centre for Excellence in Enquiry Based Learning (CEEBL) at the University of Manchester. Here we were guided through their facilities and carried out a mock EBL session on privacy which was hosted in one of their custom-built seminar rooms. The visit expanded our knowledge of EBL and allowed us to see first hand one way in which it can be approached.

We began to piece together our research on EBL and started to design the guide. We decided to produce a 'flip guide'; the staff guide can be read from one side to the middle and then flipped over to read the student guide. We hoped that the design of the guide encompassed the philosophy that EBL brings students and staff onto a more even keel. We decided to keep the look of the guide informal and used fish and seahorses as we felt this would make it more approachable and readable for staff and students. In addition we designed two posters to advertise the project around campus, and a website to complement the flip guide.

Starting out we were all daunted by the prospect of completing a guide on a topic we knew nothing about, in four weeks. We were not only expected to research a topic that was novel to us, but also formulate the research questions! It was a new way of working, and it took some time to get used to. In the first week of work we were all enthusiastic but it was inevitable that we should hit points where we didn't quite know how to progress. It was at these moments that feedback and support from our facilitator, Jane Pritchard, became imperative, and allowed us to move on in our work.

Although we all had previous experience of working as part of a group, the EBL project really taught us what working as a team entails. After the initial getting to know one-another stage, we hit a crisis point where tensions were emerging and we were becoming stressed about the amount of work to be done. It was at this point that we realised that we had to work as a team, and a culture of trust for one another emerged.

The University of Glasgow EBL group is (from left to right in the photo):

*Jacqueline Carroll, 2nd Year Dentistry****
*Madeleine Bridges, 3rd Year Theology & Religious Studies****
*Alistair Hood, 4th Year Anatomy***
*Daisy Hope, 4th Year Psychology****
*Jamie Wisbey, 3rd Year Law****
*Lisa Storck, 3rd Year Chemistry**
*Kate Thomson, 3rd Year Zoology**

* funded by HEA Centre for Bioscience
** funded by University of Glasgow's Learning & Teaching Development Fund
*** funded by the University of Glasgow's Chancellor's Fund.

The Enquiry Based Learning project was an empowerment for all of us. At no point earlier in our university careers had we felt such ownership and independence in our work. What we learnt through producing the guide will surely aid us in completing the rest of our degrees. The second phase of the project has now started, with each student intern working with a member of academic staff. In Biosciences, we (Kate and Lisa) will be working with Anne Tierney to develop EBL materials for first year biology students and Alistair will be working with Anne to develop materials for final year bioscience students taking the "Business & the Biosciences" option. Watch this space for updates!

The EBL website can be found at: *www.gla.ac.uk/learn/* by clicking on "Good Practice Guides".

Hard copies of the flip guide can be obtained from Anne Tierney, Faculty of Biomedical & Life Sciences, University of Glasgow, 0141 330 8480, a.tierney@bio.gla.ac.uk

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