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NON-BEAN COUNTERS

THIS ISSUE OF THE BULLETIN contains several articles about mathematics, or rather about the average bioscience student's fear/hatred/incompetence at mathematics, and what we as university teachers might do about it. Quantification is just as important in the biosciences as it is in the hard sciences and engineering. I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind [1] Descriptions of biological organisms and phenomena are alright, but you need to have some conception of the size of what is being described, whether it is typical or average, whether the phenomenon is reproducible, etc.

Where does this fear of maths come from? Is it from school or from everyday life? Shop assistants and bar staff don't have to add up any more: the till tells them what change to give. Do they have any idea of whether the numbers are correct or not? Hospital lab staff are instructed to put standards through the analysers from time to time to check that the values that are obtained are sound. Do your students simply believe the numbers that come up on the spectrophotometer: do they ever check, and do we tell them that they should do this?

So dealing with accurate numbers and measurements is important in bioscience and so too is the ability to deal with approximations. Rough calculations are good, but calculators militate against this! It helps if you have some idea of what the answer is going to be when you are using a calculator. You don't always need to be highly accurate: a mitochondrion is *about* the same size as a typical bacterial cell. The number of cells in the human body is *about* 10^{14} . The average molecular weight of an amino acid residue in a protein is *about* 100, so a protein of M_r 25,000 has

about 250 amino acids in it. Not many students know these things, although I am sure that we tell them. For some reason they are rarely happy with rough, in the head, calculation. Why is this?

Should we be teaching these mathematical skills, and not just skills but shortcuts and how to do "back of the envelope calculations" or should we expect students from high school to come equipped with them? Expectations or not, we still have to cope with students who are totally flummoxed when asked to make a one-in-ten dilution of a solution, or calculate the magnification of a micrograph. And I'm not even mentioning statistics at this point! In this edition of the *Bulletin* we offer an article by Vicki Tariq on using an e-learning approach to maths teaching, and Nancy Rothwell's article reminds us that school children see physical sciences as more difficult (they are) which leads to lower take-up of courses and inevitably escape from maths as much as possible. There are two reasons for this: one is that they don't like doing "hard" things, and the other is that seeing that these subjects such as Physics, Chemistry and Maths as "hard," they calculate that they will achieve lower exam grades and therefore not be so well placed for the university entry competition. The fact that there are quite a few bioinformatics courses running in the country as well as bioinformatics modules appearing in undergraduate courses, adds emphasises further that maths and IT skills are vital. Please join in the debate . . .

[1] Lord Kelvin (*Popular Lectures and Addresses, 1889-94*)

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2 TAKING A FAST APPROACH TO IMPROVE THE ASSESSMENT EXPERIENCE

HOW DO WE ENSURE THAT an assessment regime supports student learning? And, if computer-based assessment is part of the mix, what can we do to optimise its positive impact? These are concerns shared by two FDTL4 projects, FAST and OLAAF (*Formative Assessment in Science Teaching and OnLine Assessment and Feedback, respectively*). FAST, described in an earlier edition of this publication (Gibbs, 2003), is a co-production of the Open University and Sheffield Hallam University. OLAAF is centred at Birkbeck, University of London, and comprises six other consortium partners plus an 'interest group' with nine representatives.

These projects, through their development work over the past 2½ years, have addressed a wide variety of issues surrounding assessment. Both have focused almost exclusively on pedagogy within various disciplines in science, with a strong coincidental bias toward biosciences, and both projects are largely concerned with finding ways to improve formative assessment. The projects have web sites containing much more information than can be communicated here, and we encourage you to have a look: <http://www.open.ac.uk/science/fdtl/index.htm> <http://www.bbk.ac.uk/olaaf/>

I have been associated with both projects: with OLAAF as its Director and with FAST as a contributor. Fortuitously, the projects' overlapping concerns mean the work I am doing in a development project for FAST represents a part of the work I would be doing anyway for OLAAF! Undoubtedly, though, what one might encapsulate as 'the FAST approach' — at its core, a conceptual framework for making sense of the way students respond to assessment — has

invigorated my OLAAF work. The crosstalk between the projects also has underlined a key element of the OLAAF project's philosophy: that computer-based assessment is but one weapon in the assessment arsenal, not inherently better or worse than any other, and that what matters most is to find the most effective and efficient mix of assessment tools that meet the learning needs of your students.

What follows is a brief description of a 'FAST development project' I have been undertaking over the past two academic years (this is just one of about 30 ongoing development projects; see the FAST web site for a list and descriptions). But first, a further few words about the FAST framework.

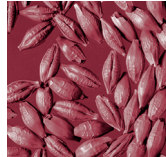
FAST is underpinned by a conceptual framework elaborated by Gibbs and co-workers (see e.g. Brown *et al.*, 2003) that identifies 11 conditions under which assessment supports student learning. In short, 4 of the stated conditions relate to student engagement (e.g. capturing student time and effort, and ensuring an appropriate distribution of that effort across topics and weeks) with the other 7 relating to the feedback students receive on their work (e.g. the form, quality and timeliness of feedback, and the understanding and use of this feedback by students, etc.). Each of the FAST development projects is centred on consideration of one or more of these conditions within the context of the assessment regime that the participant has chosen to study.

My development project concerns the assessment regime we have designed for a module at Birkbeck, *Molecular Cell Biology* (MCB), undertaken in the Spring and Summer terms of the first year of our bioscience BSc programmes. All of our programmes are designed for mature

students who undertake their degrees over four years, part-time, attending classes in the evening. This situation amplifies concerns that most teachers face with respect to first year students: that the students must settle into a study routine that is efficient and effective and they must keep a steady pace of study through the course. Because we have observed that establishing such a routine represents a major challenge for many of our students (many will be returning to education after a significant hiatus), in MCB we effectively force it upon them! We do this (in part) by using frequent summative computer-based assessment (CBA), comprising short tests (12–16 items) targeting relatively small chunks of the course material. After students take the tests for a grade (in timetabled sessions), the CBA are made available (now with automated feedback) on the web as devices for revision. Analysis of the outcomes for previous cohorts of students has shown that this regime is well-received by the students and is beneficial overall, especially for those who assiduously used the web-based tests for revision, and particularly for a subset of students whose first language is not English (Baggott & Rayne, 2001; Rayne & Baggott, 2004).

In my FAST development project, I have aimed to evaluate students' attitudes to study using the Study Process Questionnaire (SPQ; Biggs *et al.*, 2001) and to gain an impression of their 'assessment experience' using a tool developed for the FAST project, the Assessment Experience Questionnaire (AEQ; see Brown *et al.*, 2003). Because many of the students undertaking MCB also simultaneously take another module that has a completely different and more traditional assessment regime (i.e. a few pieces of written work, plus an end of year theory exam), I have taken the opportunity to administer the questionnaires to both classes to see if any I can identify any emerging issues that may pertain to the contrasting regimes.

A full analysis of last year's questionnaire data has yet to be completed, and in any case, we await the administration of the questionnaires to this year's cohort before making any firm conclusions. In short, we are gratified to find that for last year's cohort both modules scored well on the AEQ,



although significant differences in scores, biased positively toward MCB, emerged for items relating to the learning benefits of the assessments and to the quality and timing of feedback. We will follow up the questionnaires with student interviews (with representatives from both cohorts) at the end of this academic year in an attempt to clarify any emerging issues in areas for which the questionnaires lack the required acuity.

When complete, full results of this and other FAST development projects will be reported as case studies; these will become available via the FAST web site. We will also be reporting on other aspects of this work — and much more besides, as case studies are completed over the Summer — on the OLAAF web site.

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THE FUTURE OF BIOLOGY IN THE UK

STAFF IN UNIVERSITIES always have something to complain about — like most people I suppose. Too much work to do; too many new regulations and accountabilities, and more money is always needed — for research, for teaching and for buildings (not to mention salaries of course). I am more fortunate than most, in that I work in a large Faculty of Life Sciences in a very large university (the largest by many measures), and biology is doing well. The Chancellor of the Exchequer apparently views Life Sciences as important for future economic growth, student applications are buoyant and the quality of undergraduate applications is generally high.

In spite of all this, like many of my colleagues, I am concerned about the future of biology in the UK. Biology is a science which is heavily dependent on strengths in maths, physics and chemistry. Modern biology is becoming increasingly more quantitative, so a good grounding in the physical sciences is important for undergraduate courses in Life Science. Strong research and teaching in maths, physics and chemistry at university level are necessary, not only for biology, but for many other subjects such as pharmacy, engineering, computing, medicine and veterinary science. So it is a concern that some universities are closing departments of maths, physics and chemistry, largely due to declining numbers of applicants for their degree courses. This will inevitably impact not only on universities, but also on the key industries in the UK in engineering, pharmaceuticals and food manufacturing. These days, school children are turning away from the hard sciences (and modern languages) at school and university. Psychology and forensic science on the other hand are flourishing — perhaps due in part to media coverage.

There are probably several reasons for this decline. Young people apparently see physical sciences as

more difficult — and this seems to be borne out by evidence that it is harder to get high grades in these subjects compared to some others. They are also seen as boring and not trendy. When did you last see an interesting film, TV programme or article about a nuclear physicist? Though Russell Crowe did a good job as a mathematician (in *A Beautiful Mind*). Girls in particular see few role models in scientists, and young children I talk to think that all scientists are old, male, with strange hair and thick glasses (admittedly some are, but not all).

Another problem is that young people do not get to do the exciting and captivating parts of science that people of my generation did. The excitement of building electrical currents, blowing things up and cutting up dead animals is now rare, because of cost and concerns for safety and who will get the blame if something goes wrong. The new curriculum for early school years is trying to address this by better integrating science — but we are never going to see eight year olds playing with mercury on the bench again — perhaps just as well, but it was fun.

The decline in science in schools and universities creates a vicious circle where fewer and fewer school teachers are trained in physical sciences. It is no surprise that they are struggling to teach, often several subjects, for which they have little background apart from their own experience at schools. Schools, universities and industry need to work together more closely if we are to avoid falling behind the ongoing economics of China, India, Singapore and South Korea which value science so highly.

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USING A CONTEXTUAL E-LEARNING APPROACH TO TEACHING MATHS

IN JANUARY 2005 THE HIGHER Education Academy's Centre for Bioscience, in association with the Academy's National Teaching Fellowship Scheme funded a two-day workshop and discussion forum, which was hosted by Loughborough University. Fourteen colleagues from ten UK higher education institutions, the Centre for Bioscience, and the Chief Executive of the Educational Broadcasting Services (EBS) Trust came together to discuss (i) key issues surrounding the perceived decline in the mathematical competencies of life science undergraduates, and (ii) a proposal to develop an e-learning resource to support students in their acquisition and practise of those mathematical skills considered essential to a wide diversity of life science disciplines.

OPENING DISCUSSION OF KEY ISSUES

The programme began with a lively discussion of participants' perceptions of their students' mathematics knowledge and skills, providing an insight into those experiences that had helped formulate these perceptions. While colleagues described some students' mathematical competencies as 'inadequate', 'worrying' and even 'dangerous', there was a consensus that students lacked confidence and were often fearful of anything mathematical, avoiding modules with a significant maths content whenever possible. In addition, many students lacked the ability to apply their skills and knowledge in specific biological contexts. Participants were sympathetic towards their students' plight, appreciating that many were unprepared for the challenges and demands of higher education curricula. Many of those present are already engaged in a diversity of activities aimed at supporting students. Their endeavours range from designing and delivering 'friendly' maths courses and

workshops, to publishing text books and in-house support guides, and providing e-learning resources. There was no shortage of willingness and enthusiasm on the part of all present to try to do more to address what many perceive to be a serious decline in students' mathematical skills.

ADOPTING A CONTEXTUAL LEARNING MODEL

What can we do to encourage our students to recognise that some maths is an integral part of, and increasingly highly relevant to all the life science disciplines, that it can be exciting and can reveal new ways of viewing and interpreting biological phenomena? How can we motivate them to want (rather than need) to increase their understanding of key mathematical concepts and to extend their skills? One approach would be to adapt Coles' contextual learning model (Coles, 1997) to an e-learning environment; the former is closely related to experiential learning and to Kolb's learning cycle (Fry *et al.*, 2003).

A common teaching strategy is to present abstract information (e.g. a maths concept) first and then use biological examples to illustrate the maths in context (i.e. abstract to concrete). If we adopt Coles' model then we reverse this sequence. We present a series of highly visual, stimulating and relevant case studies that illustrate real biological scenarios or phenomena and that capture students' imagination. These would act as triggers, motivating students to want to discover and master the mathematics within them (i.e. concrete to abstract). Students would be presented with questions, tasks and calculations to complete in relation to each case study and would be provided with online tutorial support for those maths topics and concepts with which they lacked confidence or with which they were unfamiliar. They would also be provided with the opportunity to

practise and apply their skills to new problems (i.e. linking theory to practice). In short, the case studies would provide the context and driving force for learning the mathematics. On its own mathematics carries little meaning for many bioscience students and yet it is the essential mathematics associated with specific disciplines that we want them to understand and master. This problem-solving, contextual learning approach should promote the latter, encouraging more active and deep learning.

OUR CHALLENGE

Our ultimate aim is to produce a national multimedia e-learning resource to support students in their acquisition, practise and application of those mathematical skills regarded as essential to the wide diversity of life science disciplines. The resource would use video extensively, both in the presentation of the case studies and in the online maths tutorial support. The latter may be similar in format to that developed by the EBS Trust and its partner organisations in the production of 'mathtutor' (demonstrations of which can be viewed at www.ebst.co.uk/algebra, www.ebst.co.uk/trigonometry, www.ebst.co.uk/differentiation and www.ebst.co.uk/integration). The materials developed will need to cater for our increasingly diverse population of undergraduates, in terms of their prior experiences of biology and their attainments in mathematics.

LEADING THE PROCESS FORWARD

This project is an ambitious one, involving collaboration between the EBS Trust and academics representing the diversity of life science disciplines. A Co-ordinating Team, comprising participants at the January workshop and led by Vicki Tariq, is currently in the process of identifying potential



sources of funding for a pilot project. Anyone interested in participating in this initiative should contact Vicki Tariq (vtariq@uclan.ac.uk).

A full report on the outcomes of the workshop and discussion forum can be found on the Centre for Bioscience website at

<ftp://www.bioscience.heacademy.ac.uk/SIG/numeracy.pdf>. The report includes a list of useful learning resources, both textual and electronic, aimed at supporting tutors and students.

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NATIONAL SCIENCE LEARNING AND TEACHING CONFERENCE

27-28 JUNE
UNIVERSITY OF WARWICK

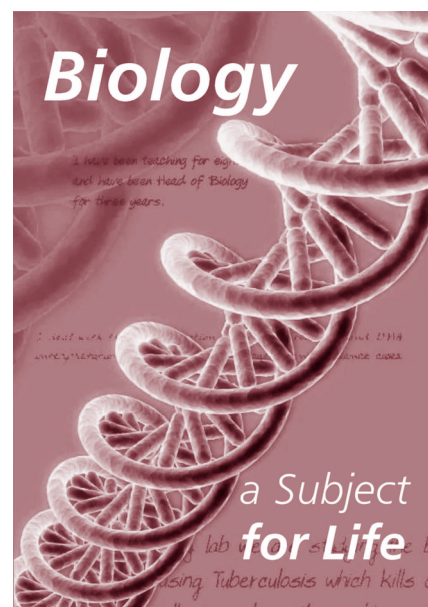
This conference, in collaboration with the subject centres for Materials and the Physical Sciences aims to bring together practitioners in the teaching of science disciplines in HE to share their experiences, identify common challenges and an opportunity to share effective practice. The programme will include keynote lectures, short oral presentations, hands on workshops, posters and exhibitions.

Further details at
<http://www.sltc.heacademy.ac.uk>

BIOLOGY — A SUBJECT FOR LIFE!

A LONG WITH REPLACING plates of chips with healthy salad bowls for school dinners, or introducing gym classes to an increasingly lethargic generation, restoring the image of science as an interesting and worthwhile subject to take in to schools is also proving to be an uphill, and sometimes impossible, struggle. How can we influence students who are, it seems, fixed in their mindset that sciences are difficult and offer no obvious career prospects (apart from forensic science)? With no immediate role models available to them on a day-to-day basis they are influenced by other more noticeable careers — the most obvious being media and communications.

Amongst the many initiatives being undertaken by a wide and varied community to attempt to enthuse and inspire school students in the sciences, the Biosciences Federation¹ (which comprises over 30 bioscience learned societies and organisations) has been contributing to the 'cause' by distributing 30,000 bright and informative A2 posters to post-16 school students in the UK. Sponsored by AstraZeneca, the main purpose of the poster, which doubles as a leaflet for teachers, students and careers advisers, is to provide a visual impact in the classroom that promotes biology as a 'high potential' subject to study at school and university. By using colourful photographs of a variety of bioscience graduates in a wide range of careers — some biology-related, some not — the aim is to show that biology can lead into all sorts of jobs. As well as traditional science jobs, those featured include: trainee patent attorney, editor, campaign officer, science reporter, trainee chartered accountant, police constable, teacher and a science education officer. We even persuaded the well-known TV presenter, Vivienne Parry, and a Derbyshire MP to be involved to illustrate how a biology degree can get



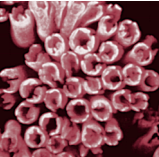
you into the media and even into power!

The leaflets have been a great success in terms of their distribution. As well as sending two free copies to all post-16 schools and colleges in the UK, we offered the leaflets for £10 per 100 (to cover distribution costs only) to schools and universities. The campaign was such a success that we ran out of all 30,000 leaflets within just 4 months, although with some universities ordering up to 2000 at a time for their Open Days it was no surprise!

We plan to produce the posters again this year and will be distributing them at the start of the new school term. If you would like to register your interest to ensure you get your copies for the 2005/6 year contact me at the address below and let us hope we can make biology a tasty subject once again.

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6 CENTRES FOR EXCELLENCE IN TEACHING AND LEARNING

The Higher Education Funding Council for England (HEFCE) recently announced the creation of 74 Centres for Excellence in Teaching and Learning (CETLs) which aim to promote excellence across all subjects and aspects of teaching and learning in higher education. With funding of £315 million over five years this represents HEFCE's largest ever single funding initiative to promote teaching and learning. The CETLs are hosted by 54 different institutions, widely distributed across England.

A full list of all the funded CETLs can be found on the HEFCE website at:

<http://www.hefce.ac.uk/news/hefce/2005/cetl.asp>.

Below are brief project outlines and contact details of a number of CETLs that will be working within the broad area of bioscience.

CENTRE FOR EXCELLENCE IN TEACHING AND LEARNING IN APPLIED UNDERGRADUATE RESEARCH SKILLS

Our multidisciplinary CETL will support the development of bioscience students' research skills through their engagement with primary research, capitalising upon our unique University museums, collections, and fieldwork facilities. We will develop innovative educational resources to support students' ability to recognise and validate problems, think independently and critically, understand project design, develop observational skills and to analyse, evaluate and communicate findings. We will create dedicated undergraduate research space and design new education materials to complement bioscience curricula developments. There will also be increased scope for students to learn, develop, and apply their research skills through enhanced work experience and research funding opportunities.

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WINNER!

Congratulations to Jessica Haglington, Department of Biological Sciences, University of Exeter, who is the winner of the Centre for Bioscience's Student Essay Competition. As a national winner, Jessica's essay has been submitted as the bioscience entry to Higher Education Academy's Student Essay Competition. Her essay is available at

<http://www.bioscience.heacademy.ac.uk/publications/essay.htm>

GENIE: GENETICS EDUCATION — NETWORKING OF INNOVATION AND EXCELLENCE

This CETL builds on synergy between world-class science and genetics education. We are developing innovative approaches through projects such as, design of modules focussed on ethics and the development of problem-based packages involving experimental design and evaluation. We are establishing a network of stake holders in genetics education through seminars and workshops; and a web-based network of shared resources — the Virtual Genetics Education Centre. Intrinsic to our philosophy is the embedding of generic skills and the application of generic approaches to other fields, such as, Biotechnology, Medicine and Law; enhancing the learning experience of a wide range of students.

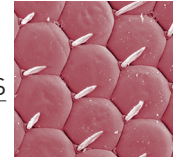
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LEARNING, TEACHING AND ASSESSMENT: A Guide to Good Practice for Staff Teaching d/Deaf Students in Science and Engineering

The guide is part of the SignsOnline project and is aimed at providing concise practical advice on different teaching situations, from lab work to formal lectures. The guide is available free of charge and can be downloaded in pdf format from the following web site:

<http://www.wlv.ac.uk/teachingdeafstudents/>



THE EXPERT CENTRE

The aim of this CETL is to facilitate the use of blended learning to support the educational (and therefore professional) development of a range of students including those in Biomedical Sciences.

Our objectives are to provide; staff and students with opportunities for enhanced professional development through innovative approaches to learning and teaching using a range of technologies and face-to-face activities; students with opportunities for research using up-to-date technologies and modern approaches to teaching and learning, and colleagues with support to develop their scholarly activity in teaching and learning.

The expected outcomes of this CETL are that diverse staff will work collaboratively, providing opportunities for personal development and reward, whilst leading to further enhancement of the student learning experience and (through research) the pedagogic knowledge base for blended learning.

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POSTGRADUATE STATISTICS CENTRE OF EXCELLENCE

The CETL aims to enhance and extend our existing excellent practice in quantitative postgraduate training, both to specialist statisticians and to users of statistics in other disciplines. This dual objective echoes the Lancaster Statistics Group's reputation for world-class statistical research at the interface between theory and applications. By collaborating with colleagues in the biological and health sciences, we will motivate and encourage topical and relevant inquiry-led training in statistical methods and their application to substantive scientific problems.

We will be developing short training courses particularly relevant to bioscience postgraduate students and look forward to welcoming your students.

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THE CENTRE FOR SCIENTIFIC LITERACY: ASSESSMENT-FOCUSED SUPPORT FOR ACHIEVEMENT IN SCIENTIFIC WRITING

This CETL will promote and celebrate scientific literacy. Building on previous collaborations (see www.assessmentplus.net), the CETL will establish Scientific Writing Units and provide a range of other mechanisms to help students develop their writing by focusing on how student writing is assessed. Based initially in psychology, the CETL will rapidly extend to a range of other disciplines, and radiate out to several satellite partner institutions. The CETL is very strongly research-oriented, and will support pedagogic and psychological research on student writing and assessment, including several PhD bursaries.

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Collaborating Institutions

Liverpool Hope University College

Aston University

ADVANCING SKILLS FOR PROFESSIONALS IN THE RURAL ECONOMY (ASPIRE)

The Aspire CETL builds on Harper Adams' excellent record in student progression, achievement and employment in professions serving the rural economy, including curricula in agriculture, crop science, animal science, environmental science and applied bio-veterinary science. We shall create a centre that brings together staff and students to provide a focus for work-based and placement learning, academic and professional skills development, learner support and learning technologies. We aim to enhance support for all students, especially those who are part-time, sandwich or work-based learners and those with disabilities. We intend to develop and share good practice with others, primarily through funded secondments.

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CENTRE FOR EFFECTIVE LEARNING IN SCIENCE (CELS)

The Centre for Effective Learning in Science (CELS) aims to create a new image for science within both the HE and school communities as more relevant, accessible and achievable. Building upon best practice in the Biosciences, Chemistry & Physics CELS will develop and trial new approaches to teaching science. For example, one focus of CELS will be creating materials to support biosciences teaching within broader degrees in Sports Science or Forensic Science (whose entrants typically have more diverse scientific backgrounds). In parallel, we will develop a range of outreach activities for schools science, for example, ExperimentsatSchool (<http://experimentsatschool.lsz.ntu.ac.uk/>) to encourage entry to HE courses.

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CENTRE FOR OPEN LEARNING OF MATHEMATICS, SCIENCE, COMPUTING AND TECHNOLOGY

The Centre will provide excellent OU teachers with the opportunity to develop and disseminate their own good practice. These 'teaching fellows', drawn from both the full-time and part-time staff, will develop their skills within development projects. We will generate new learning materials and will promote new technology approaches.

We will focus initially on assessment and e-learning. Example project areas are; interactive computer-based teaching of spectral analysis, online methods for peer assessment, and development of teaching models for more fully interactive software.

Open learning occurs at many universities and we are anxious to promote collaborations through both visits and exchanges.

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EXPERIENTIAL LEARNING IN ENVIRONMENTAL AND NATURAL SCIENCES

The CETL arises from our existing excellence in fieldwork, laboratory work and work-based learning. We will enhance our provision in these areas by using innovative new technologies, applying inter-disciplinarity and embedding the skills associated with employability and entrepreneurship more firmly in the experiential curriculum. We will adapt our laboratories and curricula to ensure that large cohort sizes, or individual disability, do not impede access to a lively, extensive and safe experiential curriculum. We will develop an innovative Immersive Vision Theatre and an equally advanced 'drop-in' Lab+ facility for the benefit of our students, visiting educational groups and the local community. A fuller description of our plans is available from the contacts staff shown.

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THE INTER-DISCIPLINARY ETHICS ACROSS SUBJECT DISCIPLINES CETL (IDEAS CETL)

IDEAS builds on the established excellence in ethics teaching in the Leeds medical course where subject specialists and ethicists help students integrate the diverse ethical issues in the course into a coherent Ethics Theme which crosses subject and year boundaries.

Within the University of Leeds, IDEAS will work in its first year within the Faculties or Schools of: Medicine, Biosciences, Business, Engineering and Nanotechnology.

IDEAS will: establish Ethics Theme Teams to integrate the consideration of ethical issues within subject specific topics, e.g. a Biosciences ethics theme team, and work with appropriate organisations in the public, private and HE sector to contribute to national and international debates on these issues and their pedagogical implications.

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BRITISH SIGN LANGUAGE GLOSSARY

We are delighted to be able to say that a British Sign Language/English online glossary for science has been launched. The resource contains a large bank of specialist terminology in British Sign Language and has been designed primarily to support Deaf students entering Higher Education and their interpreters. The web site is freely available to the education sector and the public at:

<http://www.sciencesigns.ac.uk>

THE CENTRE FOR EXCELLENCE IN TEACHING AND LEARNING: ENQUIRY BASED LEARNING

Our aim is for the CETL to be recognised as the international centre in Enquiry based learning (EBL). We will build on our existing excellence in EBL, with Medicine and Manchester Business School already international leaders in problem-based and case-based learning. It is essential that our students are educated for knowledge creation, lifelong learning and leadership. They will take on leading roles in their future working environments; directing change, asking important questions, solving problems and developing new knowledge. Basing learning on a process of enquiry will develop the necessary abilities and attitudes, while still taking account of an increasingly diversified student population. The CETL will support and disseminate new EBL initiatives inside and outside the University. We will reward those leading innovation, make available expertise and resources, and carry out extensive evaluation and research.

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ENTREPRENEURSHIP FUNDING

Can you inspire entrepreneurship in bioscience students? Grants of up to £2250 are available for the production of resource packs about entrepreneurship in the biosciences. Further details are available at <http://www.bioscience.heacademy.ac.uk/issues/entrepreneurship/funding.htm>

Deadline for receipt of applications: 22 June 2005

CENTRE FOR ACTIVE LEARNING (CeAL) IN GEOGRAPHY, ENVIRONMENT AND RELATED DISCIPLINES

CeAL will be an international centre of excellence reviewing, developing, promoting and embedding active learning. We see the Biosciences as an important constituent of the Centre and we are keen to draw on the experiences and serve the needs of the Bioscience community. Our approach enables students to construct theoretical understanding through reflection on inquiry in the field, studio, laboratory and classroom, using real sites, community-related and employer-linked activities. CeAL will be developed around communities of active learners where students and staff inquire together. A key innovative feature is joint student projects with related Schools in the University, and initially thirteen HEIs in England and ten universities overseas.

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PROFESSIONAL LEARNING FROM THE WORKPLACE

Our CETL arose from a fusion of ideas and good practice in Schools of the University engaged in Professional Learning from the Workplace (PLW) which encompasses learning for, at and through work. The School of Biosciences has been involved with PLW for many years, notably in our Accreditation of Workplace Learning scheme for students employed in NHS laboratories and the Postgraduate Certificate in Work Based Tutoring for their laboratory supervisors. We aim to be a resource and development centre for participants in PLW, preparing students for their careers and life-long learning and in training, research and disseminating PLW activities.

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10 | BIOINFORMATICS EDUCATION IN THE UK: ARE WE EDUCATING SCIENTISTS OR TRAINING TECHNICIANS?

THE ADVENT OF HIGH THROUGHPUT technologies for the global quantification and identification of biological molecules combined with advances in computing and the internet has heralded a paradigm shift in the life sciences.

However, whilst the public availability of the data resulting from these global technologies has the potential to stimulate a holistic or systems biology approach to the study of life science, it has not been matched by the presence of enough biologists with skills in mathematics and statistics to permit this potential to become a reality.

The primary response by universities in the UK has been the development of masters level bioinformatics programmes, and the past decade has seen a rapid increase in such provision (Figure 1). The growth in undergraduate bioinformatics courses has been more measured with eight universities currently offering undergraduate courses in Bioinformatics or Biocomputing for 2005 entry (<http://www.ucas.ac.uk>).

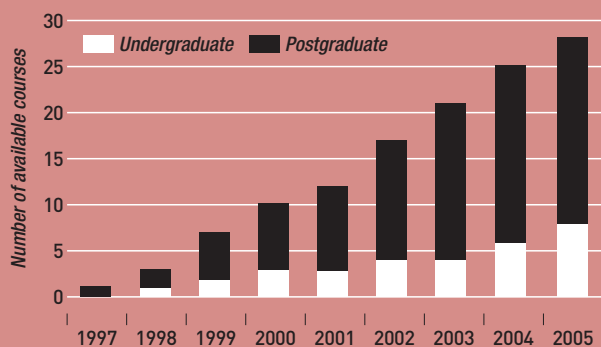
The development of bioinformatics taught programmes has made a significant contribution to the advancement of life sciences but constitutes a short term response and does not address the marked skills gap that is evident in most undergraduate programmes. Whilst many undergraduate bioscience programmes now include the use of Information Technology and software packages to retrieve and analyse biological data, graduates from these programmes are seldom provided with sufficient training in the underlying algorithms to meet the demands of academia or industry.

At least 40% of doctoral studentships currently supported by the BBSRC (<http://www.bbsrc.ac.uk>) appear to require the use of bioinformatics tools to generate information from the vast data sets currently available; graduates embarking on these programmes will require a sound understanding of these tools, or run the risk that information will be missed or more importantly that data will be misinterpreted (Iyer *et al.*, 2001). The growth in the volumes of biological data is transforming biology into an information science, requiring

Table 1 Proposed learning outcomes for undergraduates and postgraduate life science students

	Undergraduates Bioscience	Masters Bioscience	PhD Bioscience	Masters Bioinformatics	PhD Bioinformatics
Models	Appreciate simple biological models	Understand and produce simple biological models			Model and simulate biological data
Tools and algorithms	Familiar with some popular bioinformatics tools Understand underlying parameters	Good understanding of underlying parameters and algorithms for a wide range of Bioinformatics tools			Develop and implement algorithms to produce new Bioinformatics tools
Statistics	Use appropriate methods to analyse and present data	Understand a range of statistical and analytical methods and apply them to solve real-world problems in biology			Analyse complex data sets
Software Development	No formal programming knowledge			Write programmes to link tools into data pipelines or analyse data.	Develop new software suitable for commercial or public use
Data resources and Data Mining	Identify and use appropriate resources to find information Understand requirement to manage and integrate data		Use databases to manage and integrate data	Develop databases to manage and integrate private and/or public data	Use intelligent systems approaches for knowledge extraction

Figure 1 Growth in undergraduate and taught postgraduate provision in bioinformatics/computational biology in the UK



practitioners to have similar levels of quantitative and analytical skills as physicists; this has important implications for curriculum design. Teaching of the life sciences at undergraduate level has not yet adapted to this change, and graduates with good first degrees often lack the skills required to succeed in the new data driven environment. Current bioscience programmes may be training bioinformatics technicians: graduates with the ability to use a number of 'standard' bioinformatics tools; rather than life scientists with the capacity to understand the underlying algorithms and their limitations. In Table 1 we propose some learning outcomes for bioscience and bioinformatics programmes. We do not advocate turning biologists into second rate computer programmers, however it is vital that they have a thorough understanding of the biological models and the algorithms which underpin bioinformatics tools. For students to cope with this more quantitative approach to the biosciences they will need to enter university with a sound education in mathematics; admission criteria must start to reflect this change for the predicted paradigm shift in the life sciences to be realised.

REFERENCE

Iyer, L.M., Aravind, L., Bork, P., Hofmann, K., Mushegian, A.R., Zhulin, I.B. and Koonin, E.V. (2005) Quod erat demonstrandum? The mystery of experimental validation of apparently erroneous computational analyses of protein sequences *Genome Biology* available at <http://genomebiology.com/2001/2/12/research/0051> (accessed 5 May 05)

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BEE-J — VOLUME 5

THE FIFTH VOLUME OF BEE-J HAS NOW BEEN published. The articles outlined below are available on our website at

<http://www.bioscience.heacademy.ac.uk/journal/vol5/>

We also invite submissions for volume 6 of BEE-j, see the BEE-j website for further information, types of articles, layout and submission guidelines

ARTICLES INCLUDE

Lectures replaced by prescribed reading with frequent assessment: enhanced student performance in animal physiology

Peter Chevins
Keele University

Approaches to the teaching of bioethics and professional ethics in undergraduate courses

Roger Downie & Henriikka Clarkeburn
University of Glasgow

Factors affecting student choice of the undergraduate research project: staff and student perceptions

Janice Harland, Sarah Pitt and Venetia Saunders
Liverpool John Moores University

Linking Teaching and Research in the Biosciences

Heather J. Sears and Edward J. Wood
University of Leeds

BOOK REVIEWS INCLUDE

Basics in medical education by Zubair Amin and Khoo Hoon Eng
Reviewed by Ed Wood

Analysis of Genes and Genomes by Richard J Reece
Reviewed by Don MacDonald

E-LEARNING FUNDING AVAILABLE

The Centre for Bioscience is pleased to announce the availability of grants of up to £4000 in the area of e-Learning. Applications are welcomed for both pedagogic investigations and the production of learning and teaching resources. Further details are available at <http://www.bioscience.heacademy.ac.uk/projects/eLearning/etdf.htm>

Deadline for receipt of applications: 22 June 2005



12 USING THE JISC PLAGIARISM DETECTION SERVICE IN BIOLOGICAL SCIENCES

PLAGIARISM HAS BEEN much in the news recently, with several high profile cases attracting much attention. JISC guidance published in February 2005 concluded that student plagiarism in the UK was common and is probably becoming more so. The guidance recommends that deterring plagiarism is a more effective long-term strategy than detection and punishment. At the School of Biological Sciences in Leicester, we have recognised this with teaching specifically directed at prevention of plagiarism (Willmott and Harrison, 2003). However, detecting plagiarism was time consuming and reliant on the skill and experience of the individual marker and therefore it was felt that some cases may be going undetected.

The JISC Plagiarism Detection Service (www.submit.ac.uk) was adopted at an institutional level in October 2004 and the School of Biological Sciences was first at the University of Leicester to trial it. Several elements were seen as key to implementing such a system throughout the School: administration; ease of use; reliability and effectiveness; and the provision of evidence for plagiarism hearings.

The system is web based and unlike previous versions, a departmental administrator can create individual accounts for each instructor. A building block is available for integration of the system into Blackboard (v6). It is easy to upload student work in a variety of formats and in bulk.

Each piece of work, which can be made anonymous if necessary, is given an originality report. These are not produced instantly and it can take anything from a few minutes to a few hours for the system to process a batch of reports. The originality report is a statement of how much of the student text matches that of other

documents stored within the JISC PDS database. The database contains archived and recently harvested material from the internet and a database of some peer review articles. The system will also check the student essays against one another and against other essays held in the database.

It is essential for the instructor to scan the work by eye, as a high score can sometimes be attained by legitimate matches (references often match, technical language is often picked up where often there is little alternative phrasing).

The major failing of the system is that it does not include many Athens password protected or IP recognised journal sites in its database. This means that if students are copying from articles within these journals, they will not be detected using this system. JISC PDS is currently in negotiations with publishers to rectify this situation and already include a database of some journals. The system tends to concentrate on the subject areas that have been known for plagiarism, ghost writing and banks of essays for sale (e.g. law and business studies). The observed trend for biology seems to be somewhat different, with students more commonly copying (or citing incorrectly) from papers or reviews. Lecturers have begun to supplement the JISC PDS system with checks through Google, which on campus, may give access to the peer review articles often excluded from the JISC PDS.

Traditionally, when plagiarism is suspected, it can take many hours of searching to find the evidence for copying and the sources used, checking single sentences with Google is time consuming. The JISC PDS automatically produces a report that can be printed, showing in colour the student text and its corresponding matching text in the source document.

All sources found to match are shown in one document. The system picks up relatively short phrases, and it is easy to see if a student has copied some sections, but changed a few words or spellings. The system is objective and much less time consuming than checking by hand or by using Google. JISC PDS archives past material it has harvested from the web, and so can pick up matches where Google may only look at the most recent information available. This is particularly useful when student work is marked over a vacation period, where there may be several weeks between submission and checking the work.

Although the system is objective, the results it produces still need to be interpreted carefully. The originality report provides a guide but should not necessarily be used as the final analysis of the piece of work.

Using the JISC PDS prior to marking student work can lead to a false sense of security and weaken a lecturer's ability to spot plagiarism using their experience, knowledge of the student's normal level of work and other indicators such as dramatic changes in writing style.

We have seen a doubling of cases going to plagiarism hearings this year, though not all of this is attributable to the JISC PDS. While prevention is certainly our long-term goal, this system of detection and punishment will hopefully concentrate the minds of those students on the sessions where they receive instruction on what is and is not plagiarism. The system has raised some interesting questions about at what level poor citation practice is classed as plagiarism. A live demonstration of the JISC PDS during the training sessions on plagiarism would help to give not only a visual representation of direct copying, but serve as a warning to those students who deliberately plagiarise that they will be caught.

REFERENCE

Willmott, C. J. R. and Harrison, T. M. (2003) *Journal of Biological Education*, 37, 139–140.

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