ABSTRACTS: INVITED SPEAKERS

Keynote

Professor John Hedberg, School of Education, Director of the Macquarie ICT Innovations Centre, Macquarie University

Technologies and the representation of ideas

There is a change afoot and it might prove a pivotal point for the world of digital education. Technologies are more focussed on what the user wishes to achieve as an outcome, pedagogies are less focussed upon integration of ICTs and more on the need for the technologies to represent the information and knowledge of the discipline. We are moving into a time, where the technology can assist us to represent ideas in a variety of forms, to share resources and to assist with the creation of a new forms of representation. Additionally as we employ collaborative tools and access the Internet, we can co-construct representations of our understandings about the world.

Keynote

Assoc. Prof. Roy Tasker, School of Natural Sciences, University of Western Sydney

The Challenge of Visualising Science: Some Research Findings

We know that many misconceptions in science stem from an inability to relate its abstractions – mathematical relationships, concepts, and symbolism – to accurate, meaningful, mental models of invisible phenomena. We also know that you cannot create or change a student's model simply by showing them a scientifically acceptable one, particularly if it conflicts with their own.

In this presentation we will critically analyse the strengths and weaknesses of a number of visualisations from a range of scientific disciplines. Then we will use an evidence-based cognitive model for how we learn from audiovisual information, to inform best practice in using visualisation for teaching science. This will be illustrated with an example from our own research on the effectiveness of animations to assist students to build mental models of chemical substances and reactions.

Keynote

Professor Michael Jacobson, Faculty of Education and Social Work, The University of Sydney

Agent-augmented Multi-user Virtual Environments and Computational Agent-based Models: Beyond Heat from a Burning Fire?

Unlike standing next to a fire, where one automatically gets warm, student experiences in immersive, computational modeling, and advanced visualization environments do not automatically result in enhanced learning of challenging scientific knowledge and skills. Two design research studies are discussed. The first study involved an agent-augmented multi-user virtual environment in which students engaged in science inquiry activities to determine why the virtual 19th century agents were getting sick. The second study explored learning activities that varied the degree of scaffolding provided for using agent-based models of the physics of electricity. The learning sciences theoretical grounding and significant empirical findings for each study are presented and implications discussed.

Pearson Award

Paul McGreevy, Sally Pope, Federico Costa, Peter Thomson, Tonya Stokes and Vanessa Barrs, Faculty of Veterinary Science, University of Sydney

Listing of Inherited Disorders in Animals (LIDA) for cats: an on-line relational database, using non-technical descriptions written by veterinary students

The Listing of Inherited Disorders in Animals (LIDA) for cats has implemented research-led approaches to learning and teaching and used these to showcase student output of high quality. Listing of Inherited Disorders in Animals (LIDA) is a leading example of how learning outcomes can be aligned with assessment and the students' deliverables then developed into a learning resource. Exemplifying the high standard of work students can produce when thoughtfully guided and advised, LIDA began as a library-based activity

offered to Veterinary Science undergraduate students. The exercise was designed for students to develop an appreciation of the variety of congenital and inherited disorders in cats, and to reflect on the impact of these on cat welfare, describing their effects in clear, plain English. Much of the written work submitted by students for this assignment was incorporated, with their permission and acknowledgment, into the LIDA database. It now constitutes an online relational database, using non-technical descriptions, almost all credited to individual students.

ABSTRACTS: ORAL PRESENTATIONS

Brightwell, R.F. and Buchannan, D., Edith Cowan University, Perth WA

The Use Of Formative Assessment And Support MaterialsTo Assist Students In Taking Control Of Their Own Online Learning.

Traditionally, science instruction has focused on creating an interactive, intrinsically motivated approach to teaching, i.e., "delivery", but there is a need to be paying just as much attention to empower students with the ability to "receive' the science. Some of the keys to this recipe include the use of self-assessment tests; activities that require the interpretation of case studies; peer instruction interactions; online and multimedia lessons which encourage top-down/bottom up science processing strategies to decipher meaning; and simulations that test all of the science skills in action. Online materials foster autonomous learners in a science practice. The end goal progresses students to function outside a passive classroom environment so they may, without the aid of an external evaluator, shift the process of learning from the teacher to the student.

This paper addresses critical issues in Anatomy and Physiology education; how to better motivate students and help them make the connection to what is important to learn; how to get students to see the whole topic rather than minute details; how to help students who lack study skills and how to instill critical thinking skills from entry to the course so as to succeed in learning attribution to efficacy. Within this philosophical framework, formative assessment techniques provide students with the knowledge and detail that is needed to move forward in their careers, through an emphasis on critical thinking, conceptual understanding, and relevant application of knowledge.

In doing so the resources examined help students to:

- come to class better prepared for lectures
- get immediate feedback and context-sensitive help on assignments and quizzes; and
- track their progress throughout the course

Susan Worsley and Michael Bulmer, Mathematics, University of Queensland, ***Mia O'Brien***, Teaching and Educational Development Institute, University of Queensland

Threshold Concepts and Troublesome Knowledge in a Second-Level Mathematics Course

In mathematics it is possible to learn a procedure for doing many of the calculations required to pass a course without actually understanding the mathematics involved. The framework of threshold concepts provides a focus on all aspects of mathematical understanding that students need to learn. Here we may broadly view successful learning as gaining insight into what the calculations are doing and how they work. Through grasping a threshold concept students are then able to translate this to different and harder problems.

Little work has been done to identify threshold concepts in higher-level mathematics courses. Our study has looked at learning and teaching in a large second-level course taken by students in mathematics, engineering and physical sciences. This course covers topics such as advanced ordinary differential equations, vector calculus and linear algebra. Based on an analysis of course content, surveys and quizzes completed by students, and interviews with tutors and lecturers, we have identified troublesome knowledge in each area and possible candidates for threshold concepts. Visualization is central for students to effectively learn and demonstrate their understanding of many of these concepts. Implications of this work include improved assessment design and professional development and mentoring of tutors through a dialogue around troublesome knowledge.

Cranney, J., Jones, G., Morris, S., Starfield, S., Martire, K., Newell, B., & Wong, K. (University of New South Wales).

Critical reading and writing (CRW) in first-year psychology: Mass screening and targeted assistance

Many beginning students struggle with their university study because their high-school experience did not yield the basic or enabling skills essential to tertiary learning activities. A diagnostic program was designed to identify and assist students in developing psychology-specific academic literacy skills in the large Introductory Psychology 1A course at UNSW. In an early lecture period, all students were required to make a written response to a text passage (CRW test). This test required them to take and argue a position. Trained assessors marked their responses according to a number of criteria that ranged from spelling and grammar to the logic of their argument (which position they took was irrelevant). The bottom-scoring 50 students were then contacted and offered special tutorials to assist them with writing their laboratory report. In addition, a second CRW test was offered to this assisted group of students as well as a control group of students (a second chance to make up percentage points). Students who participated in the tutorials showed

improvement on some, but not all, assessment criteria. The implications of these findings are discussed in terms of discipline- *vs.* non-discipline-specific assessment criteria, and in terms of a cost-benefit analysis of the exercise.

Adam Strickland[1], Robert Williams[2], Nem Jovanovic[2], Ben Johnston[2] and Judith M. Dawes[2],
1 Dept of Computing, Macquarie University, Sydney, 2109. 2 Dept of Physics, MQ Photonics, and ARC Centre of Excellence CUDOS, Macquarie University

Build Your Own Virtual Photonics Communication System: A Photonics Simulator for High School Students

In our community outreach activities, we have been developing teaching tools to inform high school students about Optics and Photonics. While there is research supporting the idea that incorporating computer games into education can create a "strong cognitive effect", others suggest that games should merely be used as a teaching tool, rather than as a primary vehicle for teaching. Thus we chose to develop an open-ended Photonics Simulator using Flash, employing photonic components as building blocks to form a communications system, within a classroom lesson including an illustrated talk with a simple optical fibre demonstration. The virtual photonics components have the same properties as the devices used in actual telecommunications links and in our research laboratories. The software is available to download.

We trialled the Photonics Simulator during a single lesson (lessons ranged from 50 minutes to 90 minutes) with five Year 9 or Year 10 classes (from three schools - coed, girls only and boys only) during 2007. We gave them a short survey before the lesson to establish their level of knowledge of photonics, and then administered a slightly longer survey, including some repeated questions, after the lesson. The level of knowledge of photonics was significantly improved in every class and in every subgroup tested. (For example answers on "the function of an optical amplifier" improved from 16% correct/partly correct to 65% correct/partly correct). Furthermore, the "hands-on" nature of the simulator was effective in engaging the students, (84% "enjoyed playing the game") and showing them the basis of the communications systems that underpin the internet.

Suzanne Hogg and Lakshmi Srinivasan, School of Physics, University of Technology, Sydney

Empowering Physics Demonstrators to Enhance First Year Lab Experiences by Use of Real Time Visualisation – a Working DVD

The Physics laboratory program at UTS has been developed with a very open-ended approach, encouraging students to learn scientific analysis by investigating physical situations with a minimal reference to prescribed directions. The role of the demonstrator in this process is pivotal as they guide the students in their chosen exploration method. Principal Demonstrators are responsible for a class of 40 students and there will be many different approaches on which they are required to give expert guidance.

To assist the demonstrators we have developed a DVD of the experiments in the program, with easy access to the particular parts of the experiment with which they are wanting to refresh their memories before the start of an experiment. A very high proportion of demonstrators at UTS are P/T , external academics and with the new science building involving shared labs between the various sciences physics lab equipment is generally not readily available for the demonstrators to be able to set up the experiment for themselves before a lab starts.

Important aspects of the DVD project are the ability to readily update all of the material and the involvement of experienced demonstrators as the presenters of the experiments in the included video clips

In this paper we describe the background to the development of the DVDS, their relationship to the philosophy of the laboratory program and the outcomes of trials of the DVDs. In addition we examine responses to the DVD obtained through focus group sessions which indicate that care will need to be taken that this resource, created to assist demonstrators to foster enquiry in the laboratory, is not transformed into a prescriptive tool restraining student creativity and ingenuity.

Karen Burke da Silva, Narelle Hunter and Jeanne Young, School of Biological Sciences, Flinders University of South Australia

Inquiry Based Practicals: How Visually Stimulating Experiences Improve Performance and Engagement of Biology Students.

Practical laboratory experiences that are both stimulating academically and visually are more likely to engage students and result in a better learning experience. This in turn is likely to affect quality of work on assessment outcomes. The importance of basing practical experiences on relevant inquiry has been recognized throughout the literature but has not

been taken up by many university programs. By changing students' practical experience to include highly visual and stimulating laboratory experiments we were able to show that not only did students experience a more engaging and enjoyable session but the average grades achieved were significantly higher compared to less engaging laboratory practicals.

Students are expected to develop their skills during a semester and therefore we only considered the final two laboratory exercises for the cohort, thus reducing any influence of skill accumulation. Students were required to complete a highly visual inquiry based practical assessment task in which they were involved in some aspects of experimental design, achieved an average grade of 82%. In comparison, student grades for a practical assignment in which the outcome was predetermined, and in which the visualization component was static had an average final grade of 76%.

By providing students with the opportunity to design and complete their own practical experiment in which they can determine the outcome visually, clearly indicates that constructivist approach to learning is more effective in this teaching environment. Student feedback suggests that this form of learning was highly motivating and interesting and comments such as '*the best practical of the whole semester'* were given repeatedly.

Susan M. Jones[1], Ashley Edwards[1] and Natalie Brown[2], School of Zoology[1], and Centre for the Advancement of Learning and Teaching[2], University of Tasmania

Seeing is understanding: the use of online Pre-lab. exercises to enhance learning in Zoology practicals

Cognitive load theory suggests that a student's learning will be inhibited if "the instructional materials overwhelm a learner's cognitive resources" (Cook 2006: p.1076): the less prior knowledge a learner has, the more susceptible they are to overload. Cognitive load theory provides the basis for a number of instructional design rules. These include the use of multiple representations, and the use of dual mode presentations (e.g. verbal plus visual).

In our first year Zoology practical classes, we have observed that many students have difficulty visualizing what they will do in class from reading a set of written instructions. Thus they are less well prepared, and less able to take full advantage of the learning experiences offered by the practical exercises. When that exercise involves a dissection, there are ethical implications (ANZCCART 2005). We therefore prepared a series of Pre-lab exercises to support each of our dissection-based practical classes. These are PowerPoint shows illustrating the procedure for each stage of the dissection, with written comments and questions designed to highlight key learning concepts: they are loaded into our online learning site the week before the relevant practical.

To gauge the impact of this initiative, we surveyed our students before releasing the first Pre-lab, and in the penultimate week of semester. The surveys were designed to elicit information on how well-prepared they feel for their classes, and what type of preparation they do: 68% commented that they 'like to see or be shown what I have to do". We also sought feedback from the demonstrators about the types of questions being asked by the students to gauge the effectiveness of the Pre-labs in helping the students conceptualise what they would be doing in class. Preliminary analysis suggests that the pre-labs were enthusiastically embraced by the students, and that there may be enhanced learning outcomes.

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Les Kirkup, Alberto Mendez, Manjula Sharma, John O'Byrne, Kate Wilson, Jamie Quinton, Dale Scott, various universities

Do students' experiences of a service subject correspond to their expectations

What impact does a single semester of physics have on students destined to major in disciplines other than physics? As part of a national study, supported by funding from the Carrick Institute for Learning and Teaching in Higher Education, we have trialled an instrument designed to uncover expectations and experiences of non-physics majors enrolled in a first year physics subject. The trial was carried out on bio/medical science majors at a large metropolitan university. We were particularly interested in student views of the value of physics to their major area of study and whether those views were transformed over the course of the semester. In addition, we were keen to establish the extent to which students expected links to be made between the physics they studied and the discipline in which they were majoring (or likely to be majoring in). Analysis of data obtained indicates that student perceptions of the value of physics are positive and change little over the semester in which they do the subject. However some experiences, such

as the laboratory work they undertake, elicited some robust responses from students. The paper discusses the findings of the trial survey, which are related to a broader study on indicators of good practice on the teaching of physics to non-physics majors. The broadening of this study to include physics subjects in which non-physics majors are enrolled at 22 Australian universities is briefly described.

Adding Value to Physics Education Technology Simulations

Robert J. Kruhlak, and Frédérique D. Vanholsbeeck, Department of Physics, University of Auckland, Auckland, NZ, ***Colin Coghill***, Department of Electrical and Computer Engineering, University of Auckland, Auckland, NZ

The Physics Education Technology (PhET) group at the University of Colorado, Boulder has created more than 60 open source, research based simulations that cover concepts in basic physics to state of the art research. We have added value to some of the PhET simulations by tinkering with the source code. The modified simulations are easily embedded into collaborative learning environments and online assessment systems. We believe this will lead to enhanced student interaction and learning outcomes. Examples of how we use these simulations in two open source environments will be presented. The first is a MediaWiki (the software that runs Wikipedia) wiki installation and the second is an online assessment and integrated study (OASIS) installation.

Thien Le , Siegbert Schmid, Adrian V. George and Justin Read, School of Chemistry, The University of Sydney

Aligning CHEM 1405 to the needs of Veterinary Science Faculty

University students studying chemistry are exposed to a large amount of new information and only some of this information is perceived to be relevant. Chemistry educators have long endeavoured to develop teaching styles which actively engage students and highlight meaningful connections between abstract concepts and practical applications. It is believed that by increasing the relevance of the course material, this would improve student engagement levels[1]. As a consequence, there has been substantial research interest into any interrelationships between student's engagement level and the relevance of new information and any possible increase in retention time, the preference for productive educational behaviours (e.g. deep approach to learning) and ultimately academic performance.

This study examines the impact of major changes to the CHEM1405 – Chemistry 1 for Veterinary Science Unit of Study. These changes were made to assist students to recognise the relevance of chemistry to their intended career as veterinarians and improve student engagement levels. These changes affect the chemistry topics covered in the syllabus, the context in which the course material is presented and the assessment procedures. The aim of this project is to assess the impact of these changes on student attitudes, assessment performance and study approaches. This was evaluated through a combination of anonymous participation observation, end-of-semester student survey, focus group discussion, interviews and exam script analysis and assessed by comparison with existing baseline data. Possible improvements and recommendations to the revised syllabus will also be reported and any possible applications to other service courses offered by the School of Chemistry.

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Lilje, O., Breen, V., Lewis, A. and Yalcin, A., School of Biological Sciences, University of Sydney

A pilot study on the impact of an online writing tool used by first year science students

The student version of the Online Report Writing Evaluation Tool (ORWET) is a summative assessment tool that has been introduced in 2008 into the junior Human Biology unit of study in the School of Biological Sciences, University of Sydney. ORWET aims to improve students' understanding of scientific report writing. The tool presents sample scientific reports to students for marking, using the same criterion-based marking scheme provided to staff members when marking reports. The interactive environment of ORWET allows students to test their understanding of what makes a good scientific report. It also ensures students are made aware of the marking criteria and how reports are marked before producing their own scientific report. The reflective process is encouraged by the timely feedback provided by ORWET in response to students' multiple marking attempts. ORWET has been integrated into the unit of study structure as a summative assessment activity in an attempt to maximise students' perception of usefulness of the online component (Lilje et al., 2007). The eLearning tool complements the traditional experimental and reporting assessment activity thereby reinforcing the blended learning environment of the Human Biology unit of study (Lilje and Peat, 2006). This paper discusses students responses to ORWET and addresses the question of whether student exposure to sample reports, criterion-based marking and detailed

feedback lead to the development of good scientific report writing skills.

Christine Lindstrøm and Manjula D. Sharma, School of Physics, The University of Sydney

Motivation: Using factor analysis to develop an instrument to measure physics goal orientations

Goal orientation theory investigates students' beliefs in how success is achieved. Duda and Nicholls (1992) have identified four different goal orientation dimensions, namely ego orientation, task orientation, cooperation and work avoidance. Their studies, however, were on high school students investigating goal orientations in the general areas of 'classroom' and 'sports', and to date, a similar study in the specific field of tertiary physics education has not been found in literature.

For this study, 20 questions were adapted from Duda and Nicholls' original questionnaire to a physics context and distributed to students with no prior background in physics in week 3 of first semester, 2006.

The responses were analysed using exploratory factor analysis. The questions were chosen with four factors in mind, but only one of these factors came out as expected, namely the 'ego orientation'. The 'mastery' and 'interest' factors were both combinations of items belonging to the original 'task' and 'cooperation' orientations. This indicates that physics students do not believe that either cooperation or individual work alone brings success, which is not surprising as both are important in the learning process. The original 'work avoidance' orientation was split into two factors, identified as 'smartness' and 'laziness'. These suggest two groups of students: the very brightest can do very well without working too hard, whereas the 'lazy' ones are content to pass without understanding the subject, more closely resembling the original 'work avoidance' orientation.

The paper will describe how factor analysis can be used to develop educational measures.

Reference:

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Craig Savage[1], Margaret Wegener[2], Timothy McIntyre[2], Dominic McGrath[3], Michael Williamson[1], [1]Department of Physics, Colleges of Science, The Australian National University, [2]Division of Physics, School of Physical Sciences, The University of Queensland, [3]Teaching and Educational Development Institute, The University of Queensland

Teaching Special Relativity using Virtual Reality

Studying Special Relativity is often a highly anticipated experience for first-year students, yet is a difficult, abstract and poorly understood topic for them when they experience it. Studies have shown that students may fail to learn fundamental concepts, such as the relativity of simultaneity, even after advanced instruction (Scherr, 2001; 2002).

The consequences of the theory of Special Relativity, when moving at close to the speed of light, are far removed from ordinary experience; this is both part of its appeal and part of the difficulty in understanding it. One option for improving student's understanding of Special Relativity is to implement virtual reality approaches such as those used extensively in the gaming industry. The visual aspect of this approach allows the student to explore relativistic effects before developing a detailed understanding of the theoretical framework. A prototype virtual reality engine, Real Time Relativity (RTR), has previously been developed and tested at the Australian National University (ANU) to simulate the visual effects of Special Relativity (Savage, Searle and McCalman, 2006). Its initial implementation in undergraduate teaching was encouraging, but a number of limitations were found.

The current project seeks to develop and test the RTR software and an accompanying instruction manual across undergraduate laboratory classes in a number of institutions. We have made significant improvements to the compatibility, stability and usability of this software. We have also developed experiments with RTR in which students can explore the effects of near-light-speed travel utilising a social constructivist approach.

We are currently evaluating RTR and associated experiments implemented at The University of Queensland (UQ) and at ANU. This evaluation will be used to further improve RTR and accompanying teaching resources. Initial results have demonstrated a number of considerations for interface and experiment development, and positive response from students in terms of their confidence, attitude and engagement. These outcomes of this work will be discussed.

Support for this study has been provided by The Carrick Institute for Learning and Teaching in Higher Education Ltd, an initiative of the Australian Government Department of Education, Science and Training. The views expressed in this presentation do not necessarily reflect the views of The Carrick Institute for Learning and Teaching in Higher Education.

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Ian Menz, Karen Burke da Silva & Narelle Hunter, School of Biological Sciences, Flinders University of South Australia

Are Science Students' Missing Classes for the Reasons we think?

At the university level lectures are the principle means by which subject information is conveyed to students. However, across many disciplines throughout Australian universities, lecture attendance remains low. Specifically, we found student attendance in a second year Molecular Biology course at Flinders University to be only 50%. In response to this, we surveyed students to determine why they were not attending. We also surveyed lecturers to determine what their beliefs were about student non-attendance. Survey results revealed that the primary reasons that students claim they missed lectures were; the need to do work for other classes, long periods of no-contact time prior to lecture and the provision of comprehensive lecture notes provided outside of the lecture. Interestingly, lectures believed the primary reason for students not attending lectures was due to paid employment. Analysis of the two surveys suggests that academics could increase student attendance in classes, and potentially improve student learning outcomes by appreciating the other demands on student time both within and external to the university, and addressing the balance between providing comprehensive lecture notes and engaging lectures.

G. A. O'Brien and M. Cameron, School of Chemistry, University of Wollongong

Prelab activities to enhance the laboratory learning experience.

First Year Chemistry at UOW includes compulsory practical classes run weekly for 10 – 11 weeks of each semester and completion of a prelab activity is required to enter the lab for the weekly class. A Flash animation based prelab program for First Year Chemistry is being developed and the Prelabs are administered via eLearning (Blackboard) using SCORM. Prelab activities vary, depending on the practical to follow. Typically the focus is a chemical principle or a particular calculation. Other exercises include visualising molecular scale events or virtual titrations with calculations. The prelab usually includes some form of a flow diagram of the method and / or the chemistry process. This paper describes the basis of the prelab development to satisfy criteria regarding both enhanced learning in the lab environment and efficient tracking of four hundred plus students so as to free demonstrators of any checking of prelabs. We also report our first assessment of the success of the prelab activities in terms of comparison of lab marks between years and comments from experienced lab staff.

Rosanne Quinnell[1,3], Murray Henwood[1], Su Hanfling[2], Rowan Brownlee[2] , [1]School of Biological Sciences, The University of Sydney, Faculties of Science; [2]The Library, The University of Sydney, [3]*currently Learning and Teaching Fellow, Faculty of Science, The University of New South Wales.*

eBOT: a collaborative learning object repository for Australian Flora

The University of Sydney eBot project was designed to deliver a collaborative, sustainable repository for digital botanical objects. From its inception the repository was viewed a means to more effectively support learning and teaching of undergraduate Plant Sciences at the University of Sydney. The project has is potential to be used beyond the Plant Sciences and outside the university environment.Objects contained within the repository range from the microscopic to entire landscapes. They include digitised herbarium specimens and associated temporal and spatial data.

The metadata supporting the system enables effective archiving and retrieval of objects and is informed by international developments in botanical digital standards. The strength of this repository is that part of the metadata maps to the currently accepted taxonomy for the green plants. The eBot schema was derived from a range of sources including descriptive standards including the Herbarium Information Standards and Protocols for Interchange of Data (HISPID). This will ensure compatibility with digital herbaria in Australia. In addition to describing the scientific content of objects, the project addresses access and sustainability issues by including rights management data and information about the technical attributes of each object. To ensure the integrity of database content, all objects are validated by an expert reviewer prior to going live. eBot will be accessible from June 2008.

This paper discusses the role of online repositories as resources for learning and teaching.

Debbie Richards, Macquarie University

Streamed project work: Letting everyone rise to the challenge.

The main educational modifications used for gifted students are enrichment and acceleration. These strategies are widely discussed in the literature in the primary and secondary education sectors. Where programs for talented or higher-achieving students do exist in the tertiary sector, enrichment is the most common approach with acceleration occasionally employed. Another alternative is the use of streaming or ability grouping, such as we find in the NSW state school system.

Our study considers the case for streaming students according to their academic record, specifically the use of grade point averages (GPA) to allocate ICT students into two separate final year compulsory project units. While presenting the differences and features of the advanced stream versus the basic stream we also consider two main issues that ability grouping raises: homogenous versus heterogeneous groups and the Australian cultural value of egalitarianism. Studies have found that high ability students obtained considerably lower grades in mixed-ability groups than in streamed groups. On the other hand, lower-ability students received higher grades when placed in mixed ability groups than in streamed groups and performed better in subsequent examinations after having worked in mixed-ability groups than in streamed groups. The results of these studies raise an ethical issue: should high achieving students be placed in groups with low ability students, potentially at the expense of their own performance?

The prevailing view is that heterogeneous groups provide a greater benefit for below average students than they impose a detriment on high-ability students. This view may be influenced by the Australian cultural value of egalitarianism and what is known as the Tall Poppy syndrome. The result is an attitude amongst Australian students that academic excellence is not cool and certainly not to be pushed or paraded. Such a view not only limits Australia's international competitiveness but also student motivation and aspirations particularly within the 'nerdy' fields of science and mathematics education.

Alice Richardson, Brett A. Lidbury and Felicia Zhang, University of Canberra.

Activating Multiple Senses in Learning Statistics

Many students complain that learning Statistics is like learning a foreign language – there are so many words to learn and learn to use properly. Overcoming the language barrier in the learning of science subjects has recently been addressed in molecular biology (Zhang and Lidbury, 2006). Many foreign words need to be assimilated to master these subjects, along with specialised meanings for ordinary English words.

Specialised meanings for English words are also common in Statistics. For instance, a student who has not acquired the statistical meaning of a word such as "normal" might write "The whiskers of the boxplot are normally spaced" to describe a boxplot with whiskers of equal length.

Given the importance of acquiring statistical language to learning Statistics, we decided to employ language learning techniques in Statistics classes. In language teaching, new language is constantly modelled and checked via different senses, such as hearing, speaking and moving.

In this presentation we discuss the results of an experiment in an introductory Statistics course at the University of Canberra. The experiment investigates the use of multiple senses in learning simple linear regression: in particular visualisation, listening, and moving. Visualisation of data was used with quantities such as estimated regression lines and sums of squares overlaid. Group work was employed to ensure that in lectures and tutorials, students not only listened to the lecturer but also listened to each other. Movement was also used in two different ways. Firstly, students moved objects such as flash cards in a "live concept map" constructed in small groups in a tutorial. Secondly, students moved as individuals to look at other concept maps, and as a class to construct, for example, living scatterplots. The outcome of the experiment will be reported through quantitative data including a Student Attitude Towards Statistics survey, class tests and exam results.

Pauline M Ross, College of Health and Science, University of Western Sydney

Representation and Learning in Biology

This is a reflective piece on the process of identifying the difficulty students have with underlying biological concepts, and a discussion about how educators can metacognitively construct a range of representation strategies (visual, auditory, kinesthetic, analogical) to help students increase their conceptual understanding. There has been much discussion about consciously appealing to different modes of learning by presenting difficult concepts using a range of representations, but this has been done in an *ad hoc* manner, with choice of visual, anlaogy or 'wet lab' dependent on precedent, intuition, or convenience using the cornucopia of strategies we feel confident in, rather than pedagogically sound rationale. It has been known for sometime that certain representations (such as analogies) cause conceptual difficulties for students and it is unlikely that one representational strategy alone will be the panacea for creating the visual imagery students need to develop the accepted scientific conceptual framework. Multiple representations of the same concept may also confuse students because they cannot translate or link the representations we use into their conceptual framework. For example, students may not visualise and link scale and dimension of the microscopic and

submicroscopic worlds necessary for understanding enzyme action, if they are presented with a macroscopic-scale model followed by observing the macroscopic outcomes of a biochemical reaction in a 'wet-lab' with a mental submicroscopic visual model of an enzyme discussed in a lecture or animated in an on-line environment. In this presentation, I will advocate that what we, as educators, should be focusing more on the identified misconceptions and the cognitive processes underlying difficult concepts and from this determining how to use visual representation(s) to increase students' conceptual understanding. We need to pay more attention to aligning various representations with learning outcomes and the cognitive processes/layers in concepts that we want our students to develop.

Ken Sutton and Anthony Williams, Faculty of Science and Information Technology, The University of Newcastle

Developing a Discipline-based Measure of Visualisation

This paper reports on current studies in a research project concerned with assessing and improving visualisation specific to engineering and science disciplines. These studies primarily focus on establishing a reliable measure of visualisation to identify poor performers so that training and learning tasks can be developed to improve mental modelling. The visualisation measure called the 3D Ability Test (3DAT) complies with psychometric test construction standards and consists of subtests and test items within each. The 3DAT is a computer-based instrument that measures choice accuracy and response time. The methodology used to investigate subtest properties is presented and results of statistical procedures such as item analysis, reliability and validity assessment and correlation studies are reported. Factors of visualisation are examined and the benefits of using a range of subtests are outlined. A case is made for two purpose-designed subtests (dot coordinate and true length) to be seen as particularly good measures of the visualisation skills considered necessary for science-related disciplines.

We describe developmental studies conducted with unskilled participants (no prior learning) and skilled participants (prior learning) under laboratory conditions. This includes research done with first year university students in design-based disciplines such as mechanical and chemical engineering. Results revealed significant differences between disciplines and consistent evidence of gender bias favouring males. The success of collaboration between unusual partners (applied psychology and design) is discussed and argued is the relevance of visualisation to science disciplines where conceptual development is important.

In this paper we outline progress in producing an online version of the 3DAT that could be used by science disciplines across the higher education sector. Central to this project is funding provided by the Australian Learning and Teaching Council (ALTC). The paper concludes with comments about initial development of interactive computer-based 3D learning tasks designed to improve visualisation.

Students' conceptual knowledge of mechanical waves across different backgrounds and cultures

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In recent years physics education researchers have focused on students' conceptual understanding, and many research papers have reported on students' alternative conceptions. Subsequently teaching strategies specifically designed to change students' conceptions to those which are scientifically accepted have been successfully implemented. A claim made in most of these research papers is that the ordinary kinds of teaching are, in general, not effective in improving conceptual understanding (Hake, 1998).

This project aims to test conceptual understanding in a cross-section of students across several years from high school to second year university levels. A conceptual survey in mechanical waves was developed and administered to seven different groups of students; 54 Australian high school, 270 Thai high school, 123 first year university non-major physics, 287 first year university regular physics, 69 first year university advanced physics, 48 second year university regular physics and 51 second year university advanced physics students. The results show that the level of student conceptual understanding depends directly on their level of previous engagement with physics learning. The more engagement they have had, the more conceptual understanding they demonstrate, irrespective of the kinds of teaching they have been exposed to.

Fiona White, Caleb Owens, Melanie Nguyen, School of Psychology, The University of Sydney

The Psychology of University Student Learning and Performance: Using a constructive feedback approach to effectively reduce student plagiarism among first-year psychology students

Plagiarism, the theft of ideas and words by students, challenges the efficacy of current teaching methods to encourage student independent learning and critical thinking. In addition, existing evidence within the School of Psychology at the

University of Sydney suggests that a purely deterrent approach to reducing student plagiarism (i.e., detection software) is relatively ineffective. These findings and an emerging literature led the School to develop and implement a constructive feedback teaching and learning approach. In semester one of 2008 teaching staff provided first year psychology students with one of three extracts from a journal article. Over 1400 participants were asked to read an extract and construct an appropriate paragraph in relation to a focussed research question. Responses on this question-focused writing module were submitted via *WebCT* upon which students subsequently received constructive feedback. Responses were analysed for serious breaches using plagiarism detection software and were also assessed according to writing style, referencing and (in)appropriate use of quotations. The best and worst paragraphs were then selected and posted on WebCT fully annotated with comments such as: "notice how this student has simply redescribed the evidence without changing its focus to answer the question"; "this is an excellent example of the same information being used to support the argument". In addition to this module students were provided with examples of what constitutes plagiarism, a demonstration of the frequency of plagiarism, the ease of plagiarism detection and the penalties for plagiarism. A few weeks following this exercise, students submitted their essays for graded assessment. An analysis of these essays revealed a significant fall in the number of plagiarism cases between 2007 and 2008. It is anticipated that this constructive feedback approach will have flow-on effects of enhancing student's independent learning, improving student's scientific writing and increasing academic honesty throughout the tertiary education community.

Kate Wilson, Dale Scott, David Mills, Alberto Mendez, Manjula Sharma and Les Kirkup, various universities

ACELL for Physics?

In November 2007 an ACELL-style (Advancing Chemistry by Enhancing Learning in the Laboratory) workshop was run at the University of Technology Sydney as part of the current Carrick funded project "Forging new directions in physics education in Australian universities". The purpose of this workshop was to test the ACELL evaluation process as a model for evaluating undergraduate laboratory exercises in physics. The workshop was attended by more than 50 delegates, from a number of different universities, and eight experiments were presented for evaluation using ACELL templates. The delegates were surveyed during and after the event on how appropriate they found the ACELL evaluation process for physics experiments, and what modifications would be needed to implement such a process for physics. The results of these surveys are presented with recommendations for modifying the ACELL process for application to physics experiments.

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The personalisation hypothesis in e-learning: Further developments

In recent times, substantial research activity investigating best practices for the design of multimedia instructional materials for effective e-learning environments has been conducted. One such area of study is the examination of the personalisation hypothesis first proposed by Mayer in 2000. The hypothesis indicates that student learning in virtual environments is better facilitated by the use of personalised text forms (first person, more conversational style) than by non-personalised text forms (third person, more formal style). Evidence from studies utilising both retention and transfer tests to examine students' academic performance has been used to support this hypothesis, with most of the testing having been conducted in e-learning environments in the domains of physics[1] and biology[1-2].

This work set out to examine the applicability of the personalisation hypothesis in the domain of chemistry, and to investigate whether learning style preferences, language background and gender are important. Findings from a semester 2 cohort show that there is no difference in academic performance of students who were exposed to personalised or non-personalised text, possibly due to the expertise reversal effect[3]. Currently a follow-up study is being conducted on a semester 1 cohort to determine if this is the case. The e-learning environments chosen involved compulsory pre-laboratory activities used to prepare students for the laboratory. Retention and transfer tests together with questions on this topic in the end-of-semester examination were used to investigate students' academic performance.

This presentation will describe the background evidence for the hypothesis, report the findings from the earlier investigation and the current one, and discuss the implications that these results may have for teaching and learning in chemistry and the generality of the personalisation hypothesis.

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Roy Tasker, School of Science, Food and Horticulture, University of Western Sydney, Australia

Can one version of online learning materials benefit all students?

The use of information and communications technology (ICT) has an increasing influence on teaching activities in higher education and offers the opportunity to improve students' learning experiences provided it is used in an educationally sound way. Material such as online pre-laboratory work can be accessed by students off campus at any time to allow students some timetabling flexibility whilst offering the university a cost effective means of delivery. However, does one version of any online activity benefit students with different levels of prior knowledge?

This study investigated the effectiveness of online pre-laboratory work modules on students' academic performance in a related practical exercise and the final examination. It clearly demonstrated the benefits of the module for students with weaker chemistry backgrounds as students with a relatively poor chemistry background who completed the modules performed significantly better in a laboratory titration assessment and final examination than those who did not complete them. Furthermore, this study has shown that not all students benefit from the one version of the online modules.

Felicia Zhang, University of Canberra

Language difficulties in first year Science – an interim report

A key goal of the study entitled 'A Cross-Disciplinary Approach To Language Support For First Year Students In The Science Disciplines', funded by the Carrick Institute for Learning and Teaching in Higher Education, is to examine the role of language in the learning of science by first-year university students. The disciplines involved are Physics, Chemistry and Biology. This national project also aims to transfer active learning skills, which are widely used in language teaching, to the teaching of science in first year. In addition, the project will articulate what constitutes a motivating learning environment in science teaching. The paper discusses the background to the study, reports on some of the preliminary results on the language difficulties faced by first year student cohorts in science from data collected in 2008 and discusses the framework we have established regarding the organization and delivery of first year science courses to be implemented in semester one 2009.

ABSTRACTS: POSTERS

Dr Carmel Coady and Dr Leanne Rylands, University of Western Sydney

The Use of Reflective Journals in a First Year Mathematics Unit

For many years society at large has proudly commented that 'maths was my worst subject at school'. This statement was then usually followed by some explanation of why this was so, for example, 'numbers scare me' or 'I just freeze when doing a test'. Anecdotal evidence suggests that more and more students are entering university with this mind set and this attitude may be part of the reason why fewer students are attempting the higher levels of mathematics at school. In 2008 our institution decided to introduce a new unit that was specifically designed to help students develop strategies to try to lessen the effects of maths anxiety and test phobia. This report details the introduction of a reflective journal as formed part of the assessment in a mathematics unit. Students were required to make journal entries every two weeks. These entries required students to reflect on their current exam preparation practices and to put strategies in place to lessen the effects of maths anxiety. Preliminary findings indicate that although students found this exercise helpful, it did not necessarily improve their mathematics marks. . However, even if the student's feelings towards mathematics improve, we will have gained. A positive attitude towards mathematics, by those who love it and are successful at it, as well as by those who struggle with mathematics, can only be of benefit.

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Microbial Vodcasting- supplementing laboratory time with vodcasts of key microbial skills

First-year microbiology practical classes can be chaotic environments with more than 30 inexperienced laboratory users in close proximity to microbial cultures and flames from bunsen burners. Whilst Charles Sturt University prides itself on giving its first year students extensive hands-on experience, time constraints and class size often make it difficult to ensure that each student receives adequate individual attention as required for the development of competency in key microbiological skills. To address these issues we have provided an introductory microbiology class of 277 students with short (39 seconds-3minutes) videos (vodcasts) demonstrating key microbiological skills. The subject serves 8 courses; Clinical Science, Forensic Biotechnology, Health Science (nutrition and dietetics), Medical Science, Pharmacy, Science and Animal Science. Further, 29 of the 277 students were distance education students who completed the practical component of the course during a four-day residential school. This paper describes the process of developing and delivering the vodcasts as well as an evaluation of their suitability as identified by their consumers, the students. The vodcasts were designed to ensure that each student had access to a demonstration of key microbiological skills as performed by a highly skilled microbiologist. The topics covered by the seven vodcasts were 16 streak plating, how to use a bunsen, aseptic handling, aseptic transfer, aseptic transfer from slopes, making a smear and gram staining. The vodcasts were filmed using a standard digital camera with file sizes ranging from 0.9 MB to 8 MB, hosted on a CSU server and accessed through a local version of Sakai called Interact. Towards the end of the semester a simple survey was administered to all students to gauge their use of the vodcast and their perceptions of how the vodcasts assisted with the development of skills,and their understanding of key concepts.

Keywords: mechanical waves, conceptual survey, physics education, conceptual understanding, misconceptions

Reference:

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Susan Hanfling and Southnary Tan, University of Sydney

iResearch: information skills for life – generic skill development online and on demand.

Every year the University of Sydney Library staff offer generic and discipline specific information skills training sessions that are attended by more than 30,000 students and staff. The provision of this training and learning resources to support generic skill development is a core Library service, which is continuously evaluated and refined.

Although some students enjoy visiting the Library, preferring face-to-face contact with a helpful staff member when they need assistance; the new generation of students includes a large number of independent and technologically literate individuals who regularly choose IT solutions for functions such as social networking and learning.

Students are increasingly using 'Web 2.0' applications and services such as YouTube http://www.youtube.com/index and MySpace http://www.myspace.com as part of their everyday activities. Research tells us that students commonly want to access information and resources online 24/7, and engage in absorbing learning experiences that mirror social use of technologies and allow learning at point-of-need.

The challenge for the iResearch project was to create a collaborative framework for information literacy resources that meets best practice for content and presentation, allows materials to be easily adapted; and most importantly, that offers an excellent student experience for range of learners from all disciplines.

In Semester 1, 2008, the University of Sydney Library launched a series of short, interactive online learning objects, designed to address these challenges. Currently the topics cover a range of core information skills and knowledge including finding items in a library, academic honesty and referencing. The project reflects 'real' experiences through scenario-based learning, and includes interactive games and activities.

Results of usability testing and other feedback from students and staff have indicated a positive response to the learning objects approach. The paper will discuss the development of the learning objects, assessment and evaluation of the project and planned future developments.

George Hatsidimitris[1], Rick Connor[2], Jacinda Ginges[1] and Joe Wolfe[1],[1]School of Physics, University of New South Wales, Australia, [2] E-learning, University of Sydney, Australia

Glimpses of Science revisited: "Multimedia-assisted" science activities for primary school teachers and their students

'Glimpses of Science' presents some concepts and techniques of science to the primary school classroom through a student-centred approach that utilises hands-on activities accompanied by instructional multimedia resources. The project was funded by Australian School Innovation in Science, Technology and Mathematics (ASISTM) and represents a collaborative effort between the School of Physics at the University of New South Wales and a cluster of primary schools in the Sydney metropolitan region. The modules were developed in conjunction with eight primary school teachers through a series of professional development workshops and consist of a number of inexpensive kits for hands-on activities accompanied by illustrative material in the form of teacher's notes, film clips, animations and so forth. The multimedia resources are presented in an interactive slide show: Each slide shows some information, but presents a question or instructional cue that lead to small group participation in the hands-on activity under investigation. The four modules developed cover the physics topics of sound, energy, light and the pendulum. The supporting multimedia was designed to assist the teacher in facilitating the small group work and can be viewed at http://www.phys.unsw.edu.au/ASISTM/catalogue.html. Feedback from both teachers and students suggests that the activities are engaging and informative.

Glimpses of Science can be viewed at http://www.phys.unsw.edu.au/ASISTM/

Les Kirkup and Lakshmi Srinivasan, Department of Physics and Advanced Materials, University of Technology Sydney, Australia

Enquiry oriented experiments for service subjects: Should they be different?

The recent renewed interest in enquiry based approaches to learning in science laboratories has prompted reconsideration of the role of enquiry based, or enquiry oriented, experiences for students required to enrol in a semester of physics at UTS but who are non-physics majors (NPMs) intending to major in the medical or biological sciences. In this study, supported by funding through a Fellowship from the Carrick Institute for Learning and Teaching in Higher Education, we explore the development and evaluation of enquiry oriented experiments in a first year service subject at UTS. The approaches we adopted owe much to the work of Hazel and co-workers in the 80's and 90's, and more recently the Advancing Chemistry by Enhancing Learning in the Laboratory (ACELL) group. We describe the background to the study and articulate concerns expressed by current and past NPMs regarding the physics lab work they undertook. We suggest a protocol by which senior students who have completed the service subject in earlier years may be engaged as key participants in the practical evaluation and on going development of new experiments. Such students are shown to bring a vital perspective to the evaluation of experiments that others, such as academics or demonstrators, cannot offer. A case study describing the development and evaluation of a particular experiment is outlined. Special emphasis is given to the scaffolding of laboratory experiences for students in order to prepare them for more open ended learning opportunities. The issues of relevance and context are seen as key to the engagement of NPMs in enquiry oriented physics experiments.

Chong Eng Tay, Michelle Kofod, Rosanne Quinnell, Bianca Lino and Noel Whitaker , The University of New South Wales

How does a high school outreach program engage our future scientists?

The Secondary School Enrichment Program (SSEP) is one of the outreach initiatives developed in the Faculty of Science, UNSW. In the face of declining enrolments in the enabling sciences, the program intends to foster a culture of academic generosity by bringing our current and future scientists together to participate in authentic scientific research. Developed jointly with a local, non-selective but high performing secondary school, the SSEP aims to draw talented students into university science degree programs, particularly in disciplines such as Physics, Chemistry and Mathematics.

The SSEP provides secondary school students with an insight into university campus life and how research is conducted through participation in a research project, under the mentorship of science PhD students. The mentors are provided training and the opportunity to communicate their research outside the scientific community, experience teaching, acquire leadership skills, and network with other PhD students. Since its inception three years ago, the program has obtained consistently positive feedback from the participants.

To better understand the benefits of such programs, we are investigating the program's perceived educational benefits for both students and mentors through pre- and post-program surveys and university enrolment data. The program's effectiveness will be defined in terms of increased students' interest in (a) tertiary study, (b) study in science, (c) study at UNSW, and (d) mentor satisfaction.

Here, we share our experiences in developing and coordinating the program, and evaluating its success in achieving the objectives. Discussion will focus on exploring the usefulness of such programs to reinvigorate interest in studying science at tertiary level, and the feasibility of expanding the program through the use of IT, collaboration with other schools and universities, or linking up with national outreach programs such as the CSIRO Student Research Scheme (SRS, http://www.csiro.au/org/pscs.html) and (Science and Technology Awareness Raising) STAR Peer Tutoring Program (http://about.murdoch.edu.au/star/navpage.html).

Rebecca LeBard School Biotechnology and Biomolecular Sciences Faculty of Science, The University of New South Wales and ***Rosanne Quinnell*** School of Biological Sciences Faculties of Sciences The University of Sydney (currently Learning and Teaching Fellow, Faculty of Science, The University of New South Wales)

Using assessment audits to understanding students' learning obstacles

In order to reinforce key concepts, undergraduate science students are given opportunities to link the descriptions of scientific phenomena presented in lectures to their own observations of similar scientific phenomena (biology, physics, chemistry) in practical classes.

Being able to conceptually move between the scientific phenomena and the abstracted figures or equations that represent those phenomena is a key skill. Developing this skill is the implicit objective of many undergraduate practical classes. We are concerned that students seem unable to adequately explain their observations, despite the implementation of many "how to" guides, and we are seeking to identify factors that impede students from being able to correctly translate and explain scientific data.

An audit of 118 laboratory reports was conducted to assess students' abilities to correctly record and calculate data, appropriately present data, and clearly explain the representation of their data. Each of these abilities were linked to criteria in the report marking scheme students had been provided and for the purpose of our audit, graded from 1 to 3, corresponding to whether the students completed the task poorly or not at all, adequately with some errors, or correctly and clearly. The data showed that a high proportion of students could not complete these tasks correctly and confirmed that students have difficulty moving between the phenomena they observe and its abstract presentation.

Having identified and quantified where students are having difficulties, we are designing an online learning module to improve the conceptual linkages between 1) an observed scientific phenomenon, 2) the experimental data 3) how these data are presented and 4) interpreted. By re-auditing laboratory reports, after the online module is in place, the success or failure of this approach can be determined.

Lilje, O., Breen, V., Lewis, A. and Yalcin, A., School of Biological Sciences, University of Sydney

The development of ORWET (staff version)

Human Biology is a large junior unit of study in the School of Biological Sciences, University of Sydney that employs 15-20 casual staff members to help teach in the laboratory classes and assist in the marking of summative assessment activities. There is usually a considerable turnover in these staff each year, which results in a varying level of marking experience. A staff version of the Online Report Writing Evaluation Tool (ORWET) has been created and used in 2007 and 2008 to increase staff awareness and interpretation of the marking criteria for one of the assessment activities, scientific report writing. ORWET compliments strategies already in place to train markers by providing a flexible learning environment from which staff can practice marking worked examples of the report. ORWET provides detailed feedback for each sample report so that staff can compare their interpretation of the marking criteria to that of ORWET. The tool aims to increase markers' confidence in marking and hence the quality of the feedback provided to students. Consistency in marking between multiple markers in a large unit of study will also increase student confidence in the marking process. This paper describes how the staff version of ORWET was created, its influence on consistent marking practices and the results of a staff evaluation of the tool.

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Digital video as a resource for teaching physics - A preliminary evaluation of effectiveness and some tips on how to do it better

Recent developments in digital video technologies allow video footage to be captured, edited and presented far more easily than was possible with older analogue techniques (e.g., 35mm film, VCR, etc.), making the widespread use of video in lectures a far more viable possibility. In this paper I will discuss my recent experiences with using digital video

to improve the effectiveness of examples and anecdotes in my physics lectures and to enhance, supplement or replace live physics demonstrations. I will include some tips on how to better use digital video as a teaching resource along with a preliminary evaluation of the success of digital video in lectures based on student feedback. Of particular note, the feedback shows that students almost always prefer live demonstrations to videos, even if the demonstration is unsuccessful or difficult to see, suggesting that digital video is not be an effective `low-cost' substitute for live demonstrations in the teaching of physics.

John O'Byrne, Alberto Mendez, School of Physics, The University of Sydney

Why do Physics? Where does it really lead?

In the first half of 2008, a survey was distributed to a wide range of Physics graduates across Australia. It is a major component of an effort to provide a realistic answer to the questions - Why do Physics? Where does it really lead? – based on the experience and perspective of real physics graduates in the workforce.

The survey was the product of the Working Party on 'Physics Graduates in the Workforce', part of a project funded by the Carrick Institute for Learning and Teaching in Higher Education. It sought to reach graduates from all Australian universities with physics or physics-related courses, both undergraduate and postgraduate. Over 130 replies were received, with over 70% recommending a major in Physics as useful training for a career in their field. Of those who didn't, over 70% "recommend a smaller component of Physics" in a students training. While a positive response is not too surprising from this sample, it is nonetheless a strong endorsement of physics training from those who have survived the experience.

But *what* was good about the training? More importantly, what wasn't? In describing graduate attributes, most responses strongly agreed that undergraduate physics developed problem solving skills, but communication and planning skills and awareness of ethical and social issues were all relatively neglected at both undergraduate and postgraduate levels. The responses clearly stated that all these need more emphasis.

Using survey data and subsequent interviews, plus a similar survey of employers, the Working party will construct a perspective on current physics training with suggestions on where changes in emphasis might be required. Other sciences might consider what message they may find in these results.

Steve Provost and Donnah Anderson, Department of Psychology, Southern Cross University

The Psychology of University Student Learning and Performance: using the wiki tool in blackboard to support collaborative hypertext development among first-year psychology students.

Before wikis and mind-maps there was hypertext. Somehow hypertext lost popularity at exactly the same time as its direct descendent, the world-wide web, become omnipresent. One of the problems for educators wishing to use and evaluate hypertext was the lack of availability of tools that students could understand for its generation. Times have now changed. Social networking is rampant, Wikipedia has been a huge success, and universities have now developed pervasive computer systems based on Blackboard and similar products. These provide easy-to-learn tools for hypertext creation, if you know where to look. We have been using the wiki tool in blackboard to support a collaborative hypertext project. Students in their first year of psychology are asked to gather information regarding career paths in the profession. They then cooperate in small groups with overlapping interests to present this information as a wiki on the MySCU site. At the end of semester, each group gives a brief presentation regarding their wiki and its development. Use of the wiki tool editor requires almost no training, and the majority of students were able to complete this assignment with ease. Gentle encouragement to incorporate hypertext design elements, as opposed to a linear presentation, was effective in many cases. Pleasingly, the experience leaves a (small) group of students interested in how to develop these skills further, manipulating CSSs and trying to get images on the background. Feedback on the unit was generally positive, and very few intra-group problems emerged. The success of this project suggests that the educational benefits of hypertext may now be achievable: at the very least it is now possible for educators to focus upon evaluation of the conceptual skills acquired rather than the technical details of hypertext creation for their students.

Charlotte Taylor[1], Noel Whitaker[2], Chris Hughes[2], Pauline M Ross[3], Michelle Kofod[2], Louise Lutze-Mann[2], [1]University of Sydney, Australia, [2]University of New South Wales, Australia, [3]University of Western Sydney, Australia

Using Threshold Concepts to Generate a New Understanding of Teaching and Learning Biology

Students come to tertiary institutions with misconceptions of key concepts in the disciplines they are studying. Their misconceptions commonly relate to conceptually difficult or troublesome knowledge (Perkins 1999) and can be: incomplete, contradictory, stable and highly resistant to change and remain intact despite repeated instruction at successively higher levels, being perhaps reinforced by teachers and textbooks (Driver 1983; Driver, Guesne and Tiberghien, 1985; Gabel, 1994). For sometime, we have known that a range of concepts in Biology are conceptually difficult e.g. biochemical pathways, evolution and genetics (Brown 1995; Ross and Tronson 2007, Taylor 2006, 2008), but whether these are the "threshold concepts" of (Meyer and Land 1995) is a question that needs to be explored further. We propose an alternative perspective where threshold crossing can be envisaged more productively as a cognitive process with students transported across a conceptual chasm or threshold. Misconceptions may then lie with an underlying 'cognitive threshold' and not a 'threshold concept' (Ross et al 2008). This current ALTC funded collaborative project involves three Australian universities and aims to identify the cognitive processes which underlie difficult Biological concepts; develop intervention strategies to improve students' framework of conceptual understanding, in one or more related concept areas (that is, to help the students cross a conceptual threshold); test whether students can subsequently transfer this thinking process to aid their understanding of other similarly difficult concepts (that is, to see if they have learnt how to cross unfamiliar thresholds). In this paper we present the preliminary results of a survey which asked biology academics (both nationally and internationally) to identify troublesome biological concepts in their teaching, describe the cognitive process that underlies them which may determine why they are troublesome, and to identify the links they perceive with our nominated cognitive thresholds.

Rosanne M Taylor and Melanie Collier, The Faculty of Veterinary Science, The University of Sydney, NSW, 2006

Writing critically about science: a curriculum structure for animal scientists

Critical scientific writing skills are an important outcome of science honours programs. Undergraduate students vary in their written communication quality and require considerable guided practice to develop clear, accurate scientific writing skills. Well designed, engaging learning activities and assessment tasks with scaffolding are required to support productive learning throughout the curriculum. Prompt, high quality feedback, from staff, peers and self and early remediation of writing flaws are of particular importance in preparing students for writing a thesis.

This study evaluates the impact of tasks in critical writing in years 1-3 on BAnVetBioSc students' performance in thesis preparation in 4th year honours. A series of units of study were designed to develop learning outcomes which help students sequentially develop their scientific criticism and writing. Structured learning and assessment tasks were implemented for first, second and third year students which included; a summary of a current area of controversy in animal science research (yr1); a peer-reviewed critical analysis of literature on painful practices in animal husbandry (yr2); a debate on animal ethical issues; a cutting edge journal article presentation; and literature review in biotechnology (all yr3). After completion of these assessed tasks, coordinated across 5 units, most students entering year 4 research projects (honours) were able to write a grant-style research proposal, a well structured literature review and present their work orally to their peers, providing constructive peer feedback. Students reported a high degree of satisfaction with the development of their generic skills in communication, worked readily in teams and few required remedial assistance.

Constructively aligned development of key graduate attributes is challenging but achievable in a science based undergraduate program with considerable choice of units. It requires careful monitoring and evaluation to ensure all students benefit in achieving the desired outcomes.

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Addressing some common issues encountered in large first year foundation subjects: leveraging the online environment to remove barriers to student learning.

Some of the common challenges encountered in teaching large first year foundation (service) subjects are: encouraging student engagement, particularly for non-continuing students; the impact of administrative logistics on the learning and

teaching experience where large numbers of students must access limited human and material resources; and maintaining a consistent quality of instructional approach when working with large numbers of tutors/demonstrators.

In attempting to address these issues, we have decided to focus on developing a set of assessable online pre-work and post-work modules for Fundamentals of Physics first year subject, drawing on the successful experience of developing online tutorials in a large first year class by Allen, Crosky, McAlpine, Hoffman and Munroe (2006). This work has shown an improvement in student engagement and comprehension, as well as an improvement in the logistical management of a large cohort (400+ students).

Embedded animations are provided to more closely link the phenomenon being examined (e.g. electric field and potential) with the symbolic representation of that phenomenon (e.g. $V(x) = -Ex$). Animations that visually link the phenomenon to the abstraction of that phenomenon have been proven to assist student learning (Ardac and Akaygun 2003; Talib, Matthews and Secombe 2005). Pre-work examples are contextualised in everyday occurrences where possible to improve student understanding of the relevance of the subject matter, leading to an improved engagement with the subject. Short post-work exercises are designed to reinforce lab learning and student understanding of the connection between practical lab work and theoretical knowledge provided in lectures.

The student experience will be evaluated before and after the implementation of the modules to gauge the success of the project.