Invited Speakers

Keynote

A perspective on threshold concepts in Science and Engineering

Prof Erik Meyer, University of Durham, United Kingdom

The expanding conceptual framework of Threshold Concepts is grounded in a seminal paper by Meyer and Land (2003) which is available online at http://www.tla.ed.ac.uk/etl/docs/ETLreport4.pdf

Threshold concepts are concepts which, when understood, lead to a new and previously inaccessible way of thinking about something; a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. Such a transformation may represent aspects of how people 'think' in a particular discipline, and is likely to be irreversible. Threshold concepts are also likely to be, in particular, troublesome (counter intuitive, alien) and integrative (exposing the previously hidden interrelatedness of something; other concepts). It has been argued that threshold concepts provide a new lens through which to view variation in student learning; particularly within posited conceptually discrete states of liminality.

In his keynote Erik will introduce, and provide an overview of, the developing framework of Threshold Concepts and attendant research opportunities drawing on examples from Science and Engineering.

Pearson Award Invited presentation:

The development of model of teaching focused on engagement and retention in large first year science courses

Karen Burke da Silva, David Wood and Ian Menz, Flinders University

Our objective was to produce a model to transform the way in which large first year science courses are delivered. We did this by researching the problem, directly implementing a series of changes and carefully evaluating the changes that were made. We compared student exam grades before and after the redevelopment, and found a clear improvement across each passing grade level (average 3.5%), in addition, failure and withdrawal rate dropped by 14%. More specifically, students without a biology background, who traditionally fail at twice the rate as those with a background, succeeded at the same rate after the changes were made. This clearly indicates that the initiatives introduced, such as the introduction of PASS (peer assisted study sessions) and prelectures (giving year 12 background), were especially important in giving this group of students the opportunity to perform on an even level. Most notably for the School of Biological Sciences and the Faculty of Science, the increased engagement of our students has led to significantly more students enrolling in second year topics, an increase of 21%. These data clearly detail how the overall student experience in first year biology must have improved. The student perspective on the value of our changes actually demonstrates this quite clearly. A comparison of Student Evaluation of teaching was overwhelming positive toward the redeveloped course structure with mean responses on a 7 point Likert scale up by at least one point in all categories. We are therefore able to say with confidence that not only did students do better academically, but they also enjoyed the course more and were consequently more likely to continue in Biology in their second year of university study.

Carrick Institute Invited Speaker

Towards a framework of teaching and learning indicators in Australian universities

Denise Chalmers, Carrick Institute for Learning and Teaching in Higher Education

A comprehensive review of the international context, the research literature on quality teaching and learning indicators, and teaching and learning indicators in use has been undertaken and has informed the identification of the key dimensions of quality teaching that are critical for quality learning and teaching in universities (Chalmers 2007). These dimensions are:

1. Institutional climate and systems;
2. Diversity and inclusivity;
3. Assessment; and
4. Student engagement and learning community.

These key dimensions for quality teaching are outlined briefly in the presentation. The validity of each dimension is based on extensive empirical research and a strong theoretical underpinning.

The dimensions are not independent of each other but overlap, as would be expected to occur in complex organisations. The framework reflects this complexity and overlap. However, if a university interrogates its institutional mission and practices through the different lenses of these dimensions, and makes thoughtful decisions and initiatives based on the evidence that is gathered in the process, then the outcomes for the students' learning and experiences are more likely to be enhanced.

This presentation will provide an overview of the framework and discuss the implications for university practice at the institutional, faculty, program of study and teacher levels.

Oral presentations: Symposium

Student performance in first year physics: does high school matter?

Therese Au, Manjula D. Sharma, The University of Sydney

At the University of Sydney, approximately 1 in 4 first year physics students have not studied senior high school physics. Previous studies have concluded that taking a high school physics course has a positive effect on student performance in undergraduate physics. To our knowledge, no study has examined whether students who do not study senior high school physics are negatively affected in first year physics. An educational context was found in which such a study could be performed. Thus, we investigate the consequences of integrating students with different high school physics backgrounds into the same undergraduate physics stream. By comparing students' exam marks, we discern any advantage or disadvantage to first year student performance that arises from differing high school physics backgrounds.

The sample consisted of 233 first year physics students. Of these, 109 (denoted R2E) had studied senior high school physics, and were from a Semester 1 stream known as Regular. 124 students (denoted F2E) had not studied senior high school physics, and were from a Semester 1 stream known as Fundamentals. We formed three matched groups based on students' senior high school mathematics background. Using t-distribution analysis, there was no statistically significant difference in the senior high school performance of the R2E and F2E groups. We then investigated the exam performance of the two groups when both were integrated into the same Semester 2 physics stream, known as Environmental. There was no statistically significant difference in the Environmental raw exam marks for two of the three matched groups ($p = 0.421$, $p = 0.157$), and a borderline significant difference for the third matched group ($p = 0.049$). We therefore conclude that students with no background in senior high school physics are generally not disadvantaged in the Environmental physics course, when compared with students who have studied high school physics.

Troublesome concepts in Statistics: A Student Perspective on What They Are and How to Learn Them

Michael Bulmer, Mia O'Brien, Sarah Price, The University of Queensland

When we teach it is often easy to overlook the kinds of challenges and issues that students themselves face in the task of learning. Recent literature on threshold concepts points to the significance of such problematic knowledge for student learning (Meyer and Land, 2003; 2006), yet there seems to be little work done on identifying the kinds of 'stuck places' that students may find themselves in (Perkins, 2006).

In this paper we present a study of threshold concepts and problematic knowledge within introductory statistics from the students' perspective. We asked 290 undergraduate science students to identify the concepts or ideas they found to be significant or important to their learning or in deepening their understanding. We also asked them to describe the difficulties or challenges they encountered whilst learning them, and what they did to overcome them.

To complement this inquiry, we surveyed 11 peer mentors whose task includes the identification of problematic knowledge within the statistics course, and the design of peer assisted study sessions directed at supporting students to overcome these challenges.

We were keen to consider the variation of the first year students' experiences of problematic knowledge within the statistics program, as well as the types of challenges that were nominated by both the students and the peer mentors. We were also interested to see how the student's perceptions of problematic knowledge within statistics compared with recent papers documenting threshold concepts and problematic knowledge from an academics' perspective.

An evaluation of Portfolio Assessment for Undergraduate Web Technology Unit

Steve Cassidy, Rolf Schwitter, Macquarie University

As part of a review of assessment practices in Computing at Macquarie we have trialled the use of Portfolio assessment in one undergraduate unit. One goal of the trial was to address specific concerns from student surveys about the lack of usable feedback on assessment work. Another goal was to reduce the reliance on end of year examinations while guarding against plagiarism.

The portfolio task required students to submit three items of work chosen by themselves along with one or two paragraphs of reflection on the work. We required three separate submissions of the portfolio throughout the semester; the first two submissions were for feedback only, the final one would be graded. Guidance was given in weekly practical problems as to what might be included in the portfolio but students were encouraged to set their own goals for each item of work. It was hoped that this individual approach to portfolio construction and the need to submit three times would reduce the occurrence of plagiarism among students.

The effectiveness of the changes made will be assessed by questionnaires to be administered at the end of the semester, after the final portfolio submission. We will be looking at differences in scores relating to feedback on assessment as well as posing specific questions relating to the portfolio task itself. The paper will report these results along with general reflections from the unit staff on the whole process.

Using short podcasts to reinforce lectures

Dr Steve Clark, Dr Mark Westcott, Lucy Taylor, The University of Sydney

Podcasting, the pushing of potentially mobile multimedia files to end users, is not a new tool in relation to learning and teaching. Over the past four years many higher education institutions have begun recording lectures, for example University of Washington (USA), University of Michigan School of Dentistry (USA), the University of Adelaide (Australia) and the University of New England (Australia) (Aldrich, Bell, & Batzel, 2006; Brittain, Glowacki, Van Ittersum & Johnson, 2006; Shannon, 2006; Tynan & Colbran, 2006). High-level and fully automated lecture recording solutions, such as Lectopia, already cater for podcasting, but are primarily aimed at streaming lectures. Conversely, short podcasts have many possible learning and teaching benefits, including providing a flexible means to support student learning in a way that takes into account the average human attention span, academic and student time constraints, and potential bandwidth limitations (Chan & Lee, 2005; Chan et al., 2006; Gay et al., 2006; Price et al., 2006). In this paper, we discuss the use of short audio files, recorded by an academic in the University of Sydney Faculty of Economics and Business. Files are designed to reinforce lecture content and are self-produced and uploaded to Blackboard for student subscription. We consider the impact on students, based on survey and focus group data, particularly regarding the technology itself and any learning benefits. We further consider the impact on the academic, and his experience using the technology and perceived teaching benefits. This information may be useful to academics or institutions interested in providing multimedia content for students.

The role of proof in mathematics teaching and the Plateau Principle

David Easdown, The University of Sydney

One of the most difficult learning thresholds for students of mathematics is the concept of proof. The difficulty manifests itself in several ways:

1. appreciating why proofs are important;
2. understanding a particular proof;
3. constructing proofs.

The notion of proof is fundamental to verifying mathematical facts and building a corpus of reliable knowledge. However the mathematics teacher has to be very careful about the selection of proofs to include when introducing topics, and filtering out certain details which can obscure important ideas. Indeed the word ‘proof’ is often equated with ‘obfuscation’. A poorly presented proof, even if meticulously prepared, can be frustrating and wasteful in terms of time and effort in concentration. It is extremely common for students to get lost, and think ‘why bother?’ or ‘what's the point?’. ‘We believe you if you tell us something is true. There is no need to confuse us or put us to sleep.’

Examples will be presented of a range of types of proofs, even spurious but ‘convincing’ proofs, and correct but totally ‘unconvincing’ proofs. An underlying ‘proof template’ will be given that assists in the development of technique, in much the same way as a sense of perspective is essential for the ability to draw well.

The discussion relates to recent research concerning the tension in language between syntax (form) and semantics (meaning). Practical tips will be given for approaching proofs in the classroom, and a discussion of the novel Plateau Principle which is the unspoken credo for successful research in mathematics, which says simply: ‘look for and be prepared to use a variety of plateaus as starting points for a mathematical investigation.’

Meeting expectations – A focus on professional practice in a final year undergraduate mathematics course

Layna Groen, University of Technology, Sydney

This paper argues that the achievement of many of the graduate attributes required of professional practice in operations research, or quantitative management science, can be best developed through a learning design that, not surprisingly, integrates the knowledge, skills and values that reflect current professional practice. This necessarily places the focus of the learning design squarely on the student, and technology and communication skills at the nexus of the subject learning activities. The assessment tasks also play an important role. The first steps in the examination of the effectiveness of this form of learning design are undertaken for a final year capstone subject in the major in Quantitative Management Science. This examination is undertaken from the perspective of students and teaching staff through the analysis of discussions with students conducted at milestones throughout the semester. Positive student outcomes could be identified.

Designing and mapping a generic attributes curriculum for science undergraduate students: a faculty-wide collaborative project

Susan M. Jones, Julian Dermoudy, Greg Hannan, Sally James, Jon Osborn and Brian Yates, Christine Evans, University of Tasmania

The benefits of explicitly incorporating generic attributes into the scientific curriculum are now widely recognised. Most universities define a core set of generic graduate attributes, but acknowledge that some attributes will receive more emphasis in some disciplines or courses than in others. This project took a "whole of faculty" approach to translating the five generic attributes defined by our university into science discipline-specific exemplars. The aim was to provide a foundation for encouraging academics to explicitly integrate generic attributes into their teaching and assessment strategies. The Faculty's generic attributes policy recommends a coordinated approach to the mapping of generic attributes at a School and discipline level, with teaching embedded into units within the curriculum, spanning the years of study, and reinforced through situations of increasing complexity – an embedded, incremental and iterative model. However, despite pockets of good practice within individual schools, a degree-level approach. Has been lacking. Our faculty-wide project team used a collaborative team approach: discipline representatives attended workshops, and provided leadership and coordination roles within their schools so that all academics could contribute. The first phase of the project involved writing discipline-specific exemplars. Next, each school mapped their current teaching of generic attributes (at elementary, intermediate or advanced levels) in undergraduate units against their ideal aspirations for their graduates. These data were then compared with current teaching patterns to identify gaps in the curriculum at the level of the major. The resources developed during this project will help course and unit designers to address such disparities, and will facilitate a faculty-wide approach to developing a degree-level generics attributes curriculum.

Teaching Physics to Non-Physics Majors: Models extant in Australian Universities

Les Kirkup, the University of Technology Sydney, Dale Scott and Manjula D. Sharma, The University of Sydney

Students' attitudes to their studies affect retention rates and nowhere is that more true than in their first year at University. By the time they begin their courses many students have developed clear expectations of their university studies and where those expectations are not met or managed, there is evidence that retention rates suffer.

Students majoring in science disciplines may be required to take subjects in their first year which do not appear to the students to belong to their major area of study, e.g. statistics for ecology students, chemistry for engineering students and physics for life science students.

In this study we focus on physics subjects, or where physics is a substantial element of a subject, but is taught to non-physics majors. In particular we consider the organisation, delivery and maintenance of these within each institution.

We investigate organisational models of the teaching of Physics to non-Physics majors, often referred to as 'service teaching' in first year Science and Engineering degrees in Australia. Here we report on the models currently found in Physics departments in Australia and drivers for change in those models. The study also examines contemporary influences on the models.

This investigation is part of a larger study funded by the Carrick Institute whose aims include understanding the influence of the different models on student experience, attainment and retention.

An articulated approach to the development and evaluation of automated feedback for online MCQ quizzes

Jan Meyer[1], Sue Fyfe[2], Georgina Fyfe[2], Mel Ziman[3], Kayty Plastow[1] Kathy Sanders[1] and Julie Hill[1]
[1] School of Anatomy & Human Biology, The University of Western Australia; [2] Curtin University of Technology; [3] Edith Cowan University

This paper describes an articulated programme of development and evaluation of automatically-presented explanatory feedback comments for online, enriched-multiple choice style quizzes in Human Biology for first year university courses. The degree of articulation of the separate components of the programme arose almost unintentionally from the inclusion of common sets of demographic questions in several of the components of the work, and from continuity of logon identities, but proved to be a powerful means of reaching an understanding of the dynamics of student engagement with the online learning process and of the effectiveness of the product we were testing. In particular, links were established between expectations of academic performance and the amount of paid employment in which students were engaged, and between expected and achieved levels of performance. Students who expected lower levels of performance at the outset were also less convinced of the potential of feedback to help them with their studies. Analysis of the patterns of use of the online test revealed a serious disadvantage to working students of current accessibility to online summative assessments, and that the standard duration of the summative tests was approximately three times the preferred online work span of the younger students. 'Dose' and 'decay'-graded selective improvements in end of semester assessments in the topics covered by the feedback comments could be demonstrated.

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.

Tackling misconceptions in introductory physics using multimedia

Derek A. Muller and Manjula D. Sharma, The University of Sydney

All too often when researchers attempt to measure the learning that occurs in physics courses, they find that very little actually takes place. On a basic level, the reason for this difficulty is not hard to identify. Students come into physics classes with ideas about the subject matter that do not align with the scientific conceptions they are expected to master. More complicated, however, is determining how specifically these alternative conceptions undermine the teaching and learning process. We have studied multimedia learning involving different areas of physics with more than a thousand students over three years. We have interviewed students and collected quantitative data not only about learning, but also about student perceptions of it. Taken collectively, our results support the conclusion that misconceptions inflict their damage in two ways: they give students a false sense of knowing, limiting the mental effort they invest in learning; and they interfere with memories of recently learned scientific conceptions. Our experiments show, however, that exposing students to common misconceptions, even in non-interactive settings, can help them overcome these difficulties. We propose that misconception-based multimedia can alert students to key inconsistencies in their reasoning, and help tether their old ideas to new, scientifically accurate ones.

Medical Physics Kickstart: Designing a senior high school physics workshop

Christie Nelan, Philip Dooley and Manjula Sharma, The University of Sydney

This paper presents research into the instructional design of Kickstart physics workshops, which the School of Physics, University of Sydney offers for senior high school physics students. In the workshops they undertake experiments which are mandatory or essential for understanding examinable syllabus content. Often schools are unable to do these because of equipment or safety constraints.

The School currently offers sessions for all three core senior high school physics modules and one optional module, Quanta to Quarks. However, there have been many requests for a session on the Medical Physics option. Before a Medical Physics session could be designed, research into students' common problem areas was required to help make a more focused and relevant product one that meets the learning objectives. The purpose of this research was to come up with problems and solutions specifically for Medical Physics and to devise general principles for designing KickStart sessions in any option.

The main methods of research were a literature search, a thematic analysis of a popular internet forum for senior high school students and interviews with teachers and past students who had studied the Medical Physics option.

The research indicates that in Medical Physics the main problem areas are the theory of Magnetic Resonance Imaging and the practical components required for diagnostic scans and ultrasound technology. The main general design principle stems from the fact that the options are taught in class towards the end of the year, while the students often do the Kickstart program early on. Therefore the Medical Physics session needs to be introductory, incorporating and linking core content, and interesting enough to hold the attention of students with minimal knowledge in the area.

The results of this study will be used in the development of a Kickstart medical physics module for 2008.

Using intervention strategies to engage tertiary biology students in their development of numeric skills

Rosanne Quinnell and Eunice Wong, The University of Sydney

Tertiary Biology students are expected to calculate parameters from their experimental data gathered in practical classes, interpret the meaning(s) of these biological parameters and then discuss their findings in the context of the published literature. As teachers we expect students to have developed sound numeracy skills from their previous studies and be able to transfer these numeracy skills into their studies in Biology. However, Biology students are less than confident about performing calculations. Using research on student anxiety of learning mathematical skills (Meece et al, 1990; Boyd et al, 1998; Klinger, 2004) and self-efficacy intervention strategies (Hattie et al, 1996; Pajares et al, 1999; Phan et al, 2000; Schulz, 2005), a numeric skills task was designed for second year plant science students and has been implemented since 2001. The numeric skills task is part of establishing a dialogue to allow each student to determine their confidence in: (a) their understanding of numeric concepts; (b) their understanding of quantities used in plant physiology; and, (c) their ability to calculate and convert between units of measure. An evaluation of the task shows that although all students were able to demonstrate their understanding of a physical parameter (e.g. volume), 32% of students were not confident with applying this understanding to estimating volumes, e.g. the volume of the tutorial room (32%). A high proportion of students (47%) lacked confidence with converting between cubic metres and litres. Feedback from open-ended responses was categorised to measure student engagement with the task. Students who were the least confident with their answers had high levels of engagement with the numeracy task compared with those students who were more confident with their numeracy skills, indicating that students most likely to benefit from the task had been successfully targeted. Enabling students to engage in their own skills development appears to be a useful approach, particularly for students lacking confidence. This work is an analysis of a current assessment practice, and is being extended into a research project to help define the numeracy threshold of students in the life sciences.

Developing robust and coherent conceptions of chemistry: an integrated model

Justin Read, Adrian George, Anthony Masters and Mike King, The University of Sydney

Considerable science education research has investigated the processes of conceptual change, much of it from a constructivist standpoint. Criteria which are necessary for conceptual change to occur have been identified; the importance of intention, effort, and motivation have been described; and the influence of higher-order cognitive skills has been investigated. In addition, examples of student-held misconceptions and alternative conceptions have been described in chemistry and other areas of science – along with methods for investigating students' conceptual understanding and for addressing conceptual difficulties.

Our research has examined student conceptions in chemistry using a mixture of qualitative and quantitative methods, and has found that the coherence of conceptions is an important factor in students developing a robust understanding of chemistry. This requires not only internal coherence within the topic area under investigation, but also as part of a network of connections between topics within the domain. Drawing on these results and previous findings from the literature, an integrated model for the development of coherent conceptions will be presented, which includes overcoming barriers to conceptual understanding, and incorporates metacognitive and motivational considerations.

One Potato, Two Potato, Three Potato, Four: the use of *Hot Potatoes* software in science language comprehension

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

Reform in the teaching of Statistics swept though in the 1990s. Emphasis was placed on statistical thinking, active learning and data and concepts rather than recipes and derivations. New-style textbooks and laboratory manuals were published that employed teaching techniques from a variety of disciplines, but not from language teaching. Teaching in Genetics, generally, is taught in a transmissive style and in a foreign language, hence resulting in inaccessibility to many students. An earlier study (Zhang & Lidbury, 2006) has examined a range of language techniques in the teaching of tertiary Genetics and Molecular Biology, and has recently focussed on language learning via the Hot Potatoes software.

So several language comprehension issues arise in the disciplines of Statistics and Genetics. For example, ordinary English words such as “significant” have a restricted and specialised statistical meaning. While such specialised vocabulary is a powerful tool for experts, they can be confusing for students because these words are used in everyday English. In Genetics, there is the same issue of common English words with altered meaning in the science context, as well as a lexicon of foreign words and acronyms associated with this discipline. It has been observed that students merely highlight and reread such words without gaining the correct understanding, thus forming a barrier to knowledge construction in Genetics.

In this presentation we show the extent to which language teaching methods, implemented through the Hot Potatoes software, have improved the learning outcomes for students in introductory statistics and genetics courses at the University of Canberra. Examples of Hot Potatoes exercises will be shown, and the context in which they have been used and the way such exercises fit into the curriculum will be described.

Intervening to create conceptual change

Pauline M. Ross and Deidre A. Tronson, University of Western Sydney

It is well established in Higher Education that students arrive at university with existing schema (misconceptions) which can exist alongside new conceptions and are characterised by being personal in nature, counter intuitive, highly resistant to change and/or contradictory (Osborne and Freyberg 1985; Driver and Bell 1986; Fensham 1994; Wandersee, Mintzes and Novak 1994). Current ideas about ‘threshold concepts’ mirror this early work on science misconceptions in that some core scientific concepts are conceptually difficult, counter intuitive, and linguistically challenging (Meyer and Land 2003). As a result, there is a wealth of information indicating that the learner's developing, imperfect cognition becomes ‘troublesome knowledge’ (e.g. Perkins 1999; Wandersee, Mintzes and Novak 1994). The resolution of the conflict between a long-held misconception and the ‘counter-intuitive’, but reasoned scientific idea can be equated with crossing a cognitive threshold and leading to a different way of thinking. Sometimes this occurs quickly, more often torturously slowly, and sometimes never. The challenge for instructors is how to create an “ah-ha” moment for students and academics, likened in comic strips to a light being turned on (Liljegahl 2005) or by Meyer and Land (1993) as a transformation. One useful strategy is deliberately intervening when it is suspected the new topic could involve a threshold concept, by creating conceptual conflict that students need to resolve using reasoned scientific argument. (Gilbert, De Jong, Justi, Treagust and Van Driel 2002).

In this paper, we describe a planned strategy of creative and innovative interventions to create transformations in student thinking and learning in Biology at the University of Western Sydney. This teaching methodology has evolved following the stages set out by Biggs (2003); (i) where the student is at (ii) what the teacher does and finally (iii) what the student does. (Ross and Tronson 2004; Ross et al., 2006 and Ross et al. in press). We present results of student evaluations and focus groups to demonstrate the success and limitations of these interventions in creating change in student's conceptual understanding. We also propose a modified model of interconnecting lenses Brookfield (1995) that may help increase the frequency of transformations for learners.

Evolution of an assessment project

Ian M. Sefton & Manjula D. Sharma, The University of Sydney

We outline the evolution of a continuing project that started life as a study of students' conceptions and reasoning patterns in elementary physics and morphed into a study of exam marking. The original study used a phenomenographic approach to analyse students' written answers to a qualitative exam question that was included in the exams for two different courses. That analysis produced the kind of result that we were looking for – a hierarchical set of categories which described the patterns of reasoning and argument in the answers. It also showed that the samples from the two courses appeared to be statistically indistinguishable, which was a surprise because the two courses had distinctly different cohorts of students. A quick look at the distributions of marks awarded for the answers then showed that, according to the single marker of all the scripts, the two groups of students were indeed different.

At that stage the project took two different directions, both with a new focus on the assessment of conceptual understanding and reasoning. One strand of the investigation looked at the effects of repeating exactly the same exam question in one of the courses. The other strand was a search for different ways of analysing and describing the characteristics of answers that might correlate with the examiner's marks, together with a preliminary investigation of the marking process itself.

We describe how the approaches and methodology of the project have developed and the kinds of results that we found. We will also outline some work in progress and future directions.

Are there educationally critical aspects in the concept of evolution?

Charlotte Taylor, The University of Sydney and Chris Cope, La Trobe University

The aim of this study was to characterise the fundamental components of a threshold concept through a detailed analysis of first year undergraduate short answers about evolution.

The current definition of a threshold concept was proposed by Meyer and Land (2003) and describes concepts which require an integration of understandings such that ways of thinking are irreversibly changed. Concepts which appear to fit this definition have been identified in qualitative studies in biology (Taylor 2006, in press). Entwistle (pers comm.) has postulated that an understanding of evolution involves a transformative change in the way all aspects of biology are viewed and requires a sophisticated integration of knowledge within biology.

This study focused on students who were encountering concepts fundamental to biology for the first time, at a level where thresholds concepts should be most evident. A hierarchical scale of understanding, which was based on the SOLO taxonomy (Biggs and Collis, 1982), was developed to score student answers to a question about evolution (Taylor et al., in review). These answers provided clear examples of the SOLO prestructural, relational and extended abstract categories, but multi-structural levels of understanding could not be so easily recognised. A hypothesis could therefore be proposed that the anomaly indicated the existence of a threshold at this level. We used a phenomenographical approach (Cope, 2006) to create categories of understanding in which each higher order category is inclusive of all lower order categories (Marton 1994). This hierarchical framework reflects the transformation and integration of ideas required in crossing thresholds (Meyer and Land 2003). Distinctly different categories of understanding, created during the subsequent re-analysis of student answers, incorporated the essential features of evolution. These categories appear to incorporate the `critical aspects' which constitute a threshold concept as described by Cope (2006). Using these critical aspects we can now design learning materials and activities which explicitly demonstrate ways of making links and seeing relationships.

Creating a national online resource for enhancing assessment practices in the biological sciences

Charlotte Taylor and Mary Peat, The University of Sydney, Dawn Gleeson, Department of Genetics, The University of Melbourne, Kerri-Lee Krause[1], Kerri-Lee Harris and Robin Garnett, Centre for the Study of Higher Education, The University of Melbourne, Australia ([1]now Griffith University)

This project was one of several discipline-specific assessment projects funded by the Carrick Institute for Learning and Teaching in Higher Education during 2006-7. Entitled *Enhancing Assessment in the Biological Sciences*, the project took a collaborative approach to developing and disseminating resources to support the enhancement of student assessment in the biological sciences. University staff and students from across Australia were involved in consultations, and many staff also provided detailed written examples of their own assessment practice for inclusion in the web-based resource.

Ethics, issues and consequences: conceptual challenges in science education

Barbara van Leeuwen, Rod Lamberts, Paula Newitt, Sharyn Errington, Australian National University

The goal of this study is to examine how ethical judgement and decision-making is learnt, taught, and understood across undergraduate science courses at The Australian National University (ANU). Science education has traditionally focused on the learning of knowledge and performance of the methods relevant to specific scientific disciplines and, in later undergraduate years, on the development of critical thinking and intellectual skills to analyse this scientific information. ‘Behaving ethically’ as a generic graduate attribute is usually interpreted as professional ethics relating to behaviour in a professional setting. In the United Kingdom there is more focus on the inclusion of personal values related to science as a graduate generic attribute (Centre for Bioscience Network, UK) but few Australian studies have addressed this aspect.

The idea that science can and should have guiding principles which are understood (or understandable) and acceptable to the majority in a society is not a new one. However, a brief examination of the changes in what is considered to be ethical science demonstrates how malleable ethics can be in the face of social and cultural influences. What do our students and staff consider to be 'good' or 'bad' science? Do they agree?

This study investigates the range of courses specifically related to ethical thinking and behaviour available to science undergraduates at ANU. Data relating to the uptake of these courses and feedback by science students is presented. For example, in 2006 of 1406 undergraduate science students only 134 (9.5%) selected science courses that focussed on ethical issues raised by science. In addition, we have conducted a pilot survey of science lecturers at ANU to explore their understandings of how they incorporate ethics into their teaching and present the findings of this study. Conceptual challenges are explored for both students and staff.

Still pictures, animations or interactivity - What is more effective for e-learning?

Alexandra Yeung , Siegbert Schmid, Adrian V. George and Michael M. King, The University of Sydney

Student populations in higher education are diverse. A range of tools and teaching materials are used to develop students' understanding in different domains. Information and communications technologies have been increasingly incorporated into teaching activities in higher education. In support of this there has been much research activity investigating best practices for design of multimedia instructional materials and for establishing effective e-learning environments. A number of studies have shown that animations and pictures when used together with text and presented in a concurrent way can enhance learning.1 Recent studies have suggested that interactivity may enhance learning by allowing students to be more active learners while using technology during the learning process.2 However, there is still limited evidence to fully support this idea.

We have developed an online chemistry module with three different versions, designed to determine the most effective way for enhancing student learning and addressing misconceptions students may have. The present study investigates students' performance associated with using the different versions of the module. One version incorporates the use of still pictures, one version uses animations and simulations, and the final version uses animations and simulations together with interactivity. We will report the design considerations and development for the three different versions as well as the findings from the pilot study run in semester 1, 2007. Ultimately the findings from this study should better inform effective design of online learning materials.

First Year Experience Forum Presentations

Group Work: Horses for courses in 1st year Biology

Gary Ellem, University of Newcastle

Group work is often employed as the only sensible response to economic and staff limitations when dealing with large student cohorts. Those motivations aside, there are a number of student learning outcomes that are perhaps best achieved in a group approach, and others where a group approach is a virtual guarantee that only a portion of the cohort will meaningfully engage in the learning task. We have taken the straight forward approach of ensuring that learning areas with a social interaction component such as 'working in teams', 'team structure and function', 'hazard assessment' and 'peer review' are delivered using group work in a way that allows a direct experience and deep learning of the processes. Other learning areas that focus on individual motor and organizational skills such as microscope usage or microbial plating are taught and assessed with students acting as individuals.

Specific recognition that socially oriented tasks should be taught in a group environment suggests the obvious ideal that the group task be designed to make the most of the group environment. In this paper I examine two such group tasks that were run in 1st year biology at the University of Newcastle in 2006. The first of these `The Great Diversity Challenge' was designed to engage students in a deep learning experience regarding their own approach to working in teams along with the basic theory of team structure and function and a team approach to hazard assessment. The second engaged students in the publication and peer review processes and provided personal experience in giving and receiving criticism professionally. Student attitudes to the effectiveness of the approach were assessed using an online survey tool in blackboard that included both scale and written responses.

Moving towards constructive alignment in first year biology

Fiona Bird, La Trobe University

A change in the assessment scheme of a first semester First year Biology unit in 2007 was made to improve student performance and perceptions. Pass rate of the unit increased by nearly a third in 2007, primarily due to a relatively better performance on the multiple choice section of the theory exam which was not part of the change. The student perception of the assessment scheme did not improve and it was clear that the assessment tasks continued to encourage memorisation of isolated facts rather than assessing higher-order levels of understanding. A critical review of the unit revealed little alignment between the assessment and the learning objectives. The challenge is to develop overall learning objectives for the unit, develop criteria to assess levels of understanding in this unit, align the assessment with the objectives and finally restructure the content of lectures and practical classes to match the objectives. This talk will discuss how we are moving towards constructive alignment in this First Year Biology unit.

Educating first-year students about the benefits of conservation partnerships: an experiential approach

William Gladstone, University of Newcastle

Loss of biodiversity and habitats is one of the greatest threats to the Australian environment and education has a critical role to play in addressing this issue. Conservation of Australia's environment occurs as a partnership of government agencies, private enterprise, scientists, educators, and the community. As future leaders of conservation activities it is essential for students to gain an understanding of the application of this partnership model. This presentation describes practical work undertaken by first-year students studying in the Bachelor of Science at the University of Newcastle that has been designed to mimic a real-world conservation project. The project involves students in a partnership with government and the community to rehabilitate a local nature reserve where several endangered species are threatened by weed invasion. Students research the problem (weed invasion), quantitatively assess the impacts of weed invasion and a management intervention (community-based bush regeneration), and work alongside a community-based bushcare group and government agency during on-ground rehabilitation of the reserve. Surveys of students (via a reflective diary) have found that key outcomes have been the acquired knowledge and skills that are relevant to a critical issue for the Australian environment; a more optimistic attitude towards environmental issues and their potential to develop solutions; a positive perspective about the role of community involvement in conservation of Australia's environment; continued participation in community bushcare groups outside the classroom; and personal involvement in solving a critical conservation issue. The students' work has provided long-term monitoring of the effectiveness of the conservation activities since 2003, a task that is beyond the technical capabilities of most community volunteer groups and the financial constraints of government agencies.

Authentic-based learning: linking theory to real-life experience by instructional design to promote effective learning

Valda Miller, The University of Queensland

First year students face an array of challenges in their transition to tertiary education, not the least being large classes and multi-disciplinary curricula that prescribe a broad rather than a deep specificity of content. If students lack the ability to interpret study requirements and are not encouraged to play an active role in their learning processes, they may be overwhelmed, especially if prior knowledge of the discipline is limited or non-existent. At the University of Queensland, most first level Biology classes average 800 students from diverse academic and socio-cultural backgrounds, of which 30 – 50% have had no previous contact with the discipline. In response, there have been increased efforts to adapt pedagogical design to respond to the diverse learning needs of this large cohort of students. In an attempt to address these needs, and to establish an environment to promote discipline-specific learning communities, peer assisted study sessions (PASS) have been incorporated within the majority of first level Biology courses.

From a theoretical viewpoint, the conversion of information to knowledge in PASS conforms to a social constructivist approach, where optimal development of understanding is facilitated via a socially interactive interchange of ideas with near-peer leaders. Within this student- directed learning environment, leaders are able to identify learners' knowledge deficits and consequently design instructional tasks to address any conceptually problematic issues. In the translation of theory to pedagogy, if learning comes from a "doing" experience that fits in the framework of existing knowledge and experience, are some instructional designs more effective than others in promoting deep approaches to learning within this environment?

This presentation describes an attempt to identify and evaluate the efficacy of authentically based instructional designs to promote deep learning approaches viz. where students can adopt an active, experiential mode of learning, where students are able to see the relevance of what they are learning, and where information is processed in context and connected to existing knowledge.

Gifted and Talented Students Forum Presentations

The Advanced Study Program in Science: challenging, motivating and inspiring our best science students

Joanne T. Blanchfield, Elizabeth McGraw, Robyn Evans, Michael Bulmer, Ricarda Thier, Helen Byers, Paula Myatt, Susan Hamilton, The University of Queensland

The Advanced Study Program in Science is an enrichment program for science students at The University of Queensland which targets highly motivated, high achieving students with an interest in research and a career in science. The program is coordinated across the full three years of the degree with the core aims of:

- Providing a cohort experience with a group of like minded individuals which becomes a closely bonded learning community throughout the undergraduate experience and beyond.
- Exposing motivated and interested students to the research culture of the university and the myriad of career opportunities in science.
- Allowing these students to gain genuine research laboratory experience earlier and more intensely than in a regular undergraduate degree program.
- Challenging these students to develop complex problem solving skills.

The program has an enrolment of ~40 students per year and these students participate in a number of cohort building exercises including science camps, team assignments and social activities. The students gain academic credit for three specific courses, one in each year, which consist of seminar attendance, research projects, discussion groups and advanced laboratory exercises. The results of the research projects completed in 2nd and 3rd year are presented within an authentic science context at an Annual Undergraduate Research Symposium as either oral or poster presentations.

The Advanced Study Program has been very successful in providing immediate and accessible links between the science research occurring at UQ and the Undergraduate learning environment. This results in our brightest students being engaged, inspired and excited during their undergraduate science degrees.

Title: TBA

Tony Masters, The University of Sydney

Stimulating our Talented: The Bachelor of Philosophy (Honours) program

Dr Paula Newitt, The Australian National University

Supporting, stimulating and broadening the opportunities for talented science students led The Australian National University to establish the Bachelor of Philosophy (Honours), PhB, degree program in 2003. The degree is designed to provide supported opportunities for elite level undergraduate students to undertake research in science or mathematics from the commencement of their undergraduate studies. This paper reviews the progress of this degree following the graduation of the initial cohort of students.

Many Australian universities now offer advanced science degrees to high achieving students. The PhB degree in Science was established to offer some distinctiveness in this field by allowing a high degree of flexibility, mentoring and individually tailored programs for the 120 students in the four-year degree. The requirements to undertake significant research projects (Advanced Studies Courses) and to maintain an 80% (High Distinction) average in science courses are discussed in terms of opportunities and stresses for students and staff alike. The resource implications of providing up to 150 research projects per semester are described. Issues, both positive and negative, in involving research-only staff in mentoring or supervising research projects are raised. Debate exists between ANU staff and students about issues of time, equity, and resources devoted to this cohort of students. Whether this is a manifestation of `tall poppy syndrome' or a reflection of pressures on staff and students is currently under investigation.

Some common threads concerning student characteristics are drawn. Incoming students are likely to be focused on maths and physics (65%), expect to proceed to a higher research degree (95%), and attended a secondary school outside the ACT (65%). Surprisingly perhaps, given their top 1% Year 12 ranking, significant numbers of students, at entry, lack confidence in their academic capabilities (30%). A smaller group of commencing students (10 - 15%) aspire to benefit humanity by ultimately working for international or national policy-making institutions.

Overall effectiveness of the program at this early stage has been evaluated by student survey and feedback, retention in the degree (95%), student contributions to refereed academic publications, and future directions.

Double or nothing! Clever thinking, double-degree frustration, and returns to Science

Sandra J Welsman, Frontiers Insight, Australia

Undergraduate double-degrees are ‘a necessary disaster for science’, in the experience of one Science Dean at a major university. Double-degrees bring timetabling and logistics problems, but ‘moreso students who have to study for so long then want to leave and work’. This is especially so for degrees with Law. The Dean reported difficulties attracting top students to pursue Honours and Doctorate research. His frustrations were reinforced by heads of science schools across institutions.

These interviews were conducted as part of a research series over 2005-2006 exploring issues in academic ways, course structures, teaching and learning at disciplinary interfaces, with a focus on Law:Science double-degrees. Among other findings, academic irritation was matched by frustration among some students with limited opportunity for integration during their double-degree study.

Research-led education: challenges and experiences

Wilson A.N., Howitt S.M. and Wilson K.F., The Australian National University

A current challenge in science education is to provide students with generic research skills. A traditional science course consisting of lectures and cookbook style practicals does not necessarily teach these skills. The ANU has recently introduced two programs aimed at giving more research experience to elite undergraduate students. To some extent, these follow the recommendations of the Boyer report, suggesting that research-intensive universities capitalise on their research expertise by allowing undergraduates into research laboratories. The two research-based education programs are the Bachelor of Philosophy degree, a flexible degree where students replace six of their 24 undergraduate courses with research projects, and the honours entry degree where students participate in extension activities for selected courses. Both programs included a compulsory honours year and in both, entry is restricted, based initially on UAI or first year marks. Continuation in the programs is dependent on maintaining a defined GPA. We have surveyed staff and students involved in these programs. The results show a mostly positive response from both but also indicate that there are significant concerns, especially around student learning outcomes, increased stress on participating students and increased staff workloads. Examples of research-led activities run within both programs will be given and the staff and student concerns will be discussed.

Symposium Poster Presentations

Spotlight on online learning and teaching in sciences and technology

Daniel Carroll, The University of Sydney

The purpose of the Sciences and Technology Spotlight web site is to showcase examples of online learning and teaching at the University of Sydney. Organized by themes and discipline areas, it contains working examples, with details of the need they address and the reflections of the practitioners. These exemplar projects were supported by or are consonant with the University of Sydney elearning support initiative (2004). This initiative focuses on enhancing student learning and encourages sustainable learning technologies which would promote innovative approaches to learning and teaching.

Annotated Bibliographies Can Help Maximise Benefit of Literature Research Skills Exercises

Michelle Coulson, The University of Adelaide

This study evaluates annotated bibliographies as a way to "value-add" to written assignments, to guide students towards strong literature research skills as part of existing written assignments. While the annotated bibliography is an accepted tool for research exercises in social sciences, it is rare in most sciences disciplines. This study followed two small cohorts of biology students as they encountered annotated bibliographies for the first time. Students submitted their annotated bibliographies four weeks into a 12-week assignment. All students found the experience valuable, and felt that it increased their preparation for the final essay. Almost all students said receiving written feedback on their bibliography was helpful. However, many students were ambivalent about whether the annotated bibliography exercise improved their literature research skills. Students were asked the question, "What do you think would most improve your literature research skills?", and the most common response was "more practice". Annotated bibliographies, in effect, indirectly allow more practice, by facilitating greater effort and completion in existing essay-type assignments. Other advantages of annotated bibliographies identified in this study include timely identification of students headed down the wrong track and the ability to provide useful feedback to students in a time-effective way. Possibly the major direct benefit perceived and appreciated by students is in facilitating early commencement and thus effective time management. The annotated bibliography is concluded to be a useful pedagogical tool to enhance the outcomes of any assessment requiring literature research skills.

The importance of true/false statements in mathematics teaching and learning

David Easdown, The University of Sydney

The passive/active interface is a moment of paralysis as a student switches from a passive role of watching others do mathematics, such as a lecturers, teachers, tutors or authors, to an active role of engaging in producing mathematics and solving problems himself or herself.

A carefully chosen true/false statement can be a perfect medium or mechanism for teasing out these two contrasting active/passive roles. The act of making decisions about which mathematical techniques are appropriate engages the student in a mental tug of war and develops an openmindedness and preparedness to think outside the square. A statement can seem absurd, but turn out to be true. A statement can seem perfectly reasonable and turn out to be false.

After making a choice about technique, then the student has to follow through and use it. At times just one technique can be used to resolve truth or falsity. At other times, completely different techniques are required, which depend on whether a counterexample exists, or some general argument is required. Choices may need to be made whether to search for the needle in the haystack, or provide convincing arguments that no such needle exists.

There is nothing 'wrong' with following blind alleys, especially in a thought experiment. Making and correcting mistakes develops a robustness that takes a student deeper towards understanding, and leads to strength of technique. Resolving true/false statements is exactly the process by which research mathematicians make discoveries. It can be equally exciting for the inexperienced learner under the guidance of an experienced teacher. The no man's land of uncertainty can add spice and subtle dynamics that enhance an appreciation of the long history and evolution of mathematical ideas.

The poster will present some ideas about using true/false statements as a useful mode of learning, also both as formative and summative assessment. A novel suggestion will be introduced for incorporating true/false statements into quizzes, incorporating estimates, on the part of the student, of the likelihood of correctness of his or her choice of answer.

Engaging students through authentic research experiences

Ashley Edwards, Susan M. Jones, Erik Wapstra and Alastair M. M. Richardson, University of Tasmania

Despite curricula emphasizing student-led enquiry, some students still struggle to find relevance and excitement in their undergraduate courses. Working from the Garnett and Holmes' (1995) model of how both students and academics can benefit from research, we have designed an incremental suite of learning activities across the three years of the Zoology undergraduate curriculum that extends and enhances the student experience.

Here we describe several components of this program which have been implemented and evaluated via student feedback. These components begin in first year, including an introduction to the use of animals in research, opportunities for students to investigate "Hot topics" in Zoology via a purpose-built web page, and to interact and question "real-life" researchers about their work ("Reach into Research" seminars).

From second year onwards, students are also invited to participate in our Student Research Volunteers program: volunteers are matched with research mentors, usually postgraduate students in the School, for short-term, in-house research placements that may offer either laboratory or field experiences ranging from ?? days in the lab. to 10 day camping field trips around Tasmania. The program has been embraced enthusiastically by our undergraduates: evaluation surveys have been overwhelmingly positive. In addition, our Postgraduate students benefit from the opportunity to supervise and mentor an undergraduate student.

Third year teaching in The School of Zoology, University of Tasmania focuses upon developing our students' scientific research skills through learning activities such as group research projects, critical reviews of current literature, writing research grant applications, lectures from scientists outside the school, and training in scientific communication. These students are offered multiple "real-life" research experiences through novel and self-designed group and individual research projects. The authenticity and perceived value of these experiences is evidenced by our increased intakes into our Honours program since this project began in 2005/6.

Physclips: multi-level, multi-media resources for teaching first year university physics

Joe Wolfe and George Hatsidimitris, The University of New South Wales

Physclips: multi-level, multi-media resources for teaching first year university physics.

In an AUTC project (2005), the Physics community within the Australian higher education sector identified the pooling and development of resources as a long term objective. This poster outlines the development and use of a project, called Physclips, that contributes to this objective. Physclips is a suite of online interactive learning and teaching resources for mechanics at the late high school or university level. The project was funded by the Carrick Institute for Higher Education and is the outcome of a collaboration between a physicist and an educational multimedia developer. Topics are introduced in multimedia modules using video clips, animations, and graphics, with a narration. The modules are segmented and have pause and replay for user control of delivery. At key points, the rich-multimedia modules use contextually embedded hyperlinks to accompanying web pages that promote deeper understanding through more detailed conceptual discussion and analysis. A range of user feedback from an earlier project informed a revised approach that provided increased flexibility: the various learning objects utilised in the multimedia modules are also incorporated into the detailed support sites, whence they may be downloaded by educators, or appreciated in detailed context by student users. Initial student feedback suggests that the resource is both engaging and instructive. Further evaluation is required to investigate fully student performance and the efficacy of the design.

Physclips is at www.physclips.unsw.edu.au

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

George Hatsidimitris, Joe Wolfe and Jacinda Ginges, The University of New South Wales

Glimpses of Science aims to deliver science activities into the primary school classroom by a student-centred approach that utilises hands-on activities accompanied by instructional multimedia resources. The project is a work in progress 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. Several modules are to be developed in conjunction with the teachers and will consist of a number of inexpensive 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 a manner akin to an interactive slide show, whereby each slide acts as an instructional aid that is followed by class participation in the hands-on activity under investigation. The first module was on the topic of sound and can be viewed at http://www.phys.unsw.edu.au/ASISTM/catalogue.html. Early verbal feedback from both teachers and students suggests that the activities are engaging and enjoyable. The next stage of development will involve designing a further four modules in conjunction with the school teachers through a series of workshops.

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

Using cognitive load theory as a framework for designing a set of integrated multimedia modules to assist in the teaching of a threshold concept

George Hatsidimitris, The University of New South Wales

The present paper reports on a work in progress undertaken by an educational multimedia developer working in collaboration with a high school biology teacher in order to create a set of integrated multimedia resources to assist student understanding of homeostasis. The resources are designed to not only align with evidence-based guidelines of cognitive load theory (Sweller 2005) but also incorporate course design and evaluation considerations that pertain to threshold concepts such as those raised by Land, Cousin, Meyer and Davies (2006). Although cognitive load theory is particularly enlightening in terms of creating discrete learning objects, it does not as yet demonstrate how to deal with the complexity of threshold concepts as suggested by their "hidden interrelatedness" (Meyer and Land 2006). To this extent a discipline specific model is posited in terms of a set of integrated multimedia modules that can be further developed through a process of feedback and evaluation.

Use of traditional and eLearning components in a blended learning environment

Osu Lilje and Mary Peat, The University of Sydney

Structural changes to a human biology course have integrated an eLearning component with traditional lectures and laboratory classes. An investigation of use and perceptions of usefulness indicate that the components have been successfully blended.

Human Biology is a first year undergraduate course at the University of Sydney. In 2005 the course underwent a major curriculum review with a new structure emerging in which a significant amount of content was moved online and this became the focal point of the course with the remaining face-to-face activities (lectures and labs) blended with the new online component in a manner which emphasised equal linkage between them. This was very different from the previous course where online materials had been perceived by the students as supplemental to the course and not central, and they had reported their use of these to be essentially for revision. Over a two year period we have been investigating the use and students perceptions of usefulness of all the resources available in this course. We wanted to see if the way in which we had blended the learning materials changed the way in which students used them and if their perceptions of usefulness had changed. As we believed the blended model offered the students better opportunities for deep learning, we wanted to see if their written responses to short answer exam questions improved as a result of the new course format.

Our results are encouraging. Survey data that the components of the course are all being used in a similar manner. In particular the results show that students now report that they use all components for learning new knowledge, which is a shift from the outcomes of our previous studies (pre-the major overhaul, Peat et al. 2005) when online materials were primarily used for revision and not for learning new knowledge. This suggests that we have provided an effective blending within the learning environment. In addition whilst the assessment items remained essentially the same between the 2005 and 2006 cohorts, and the entry requirement into this advanced course was the same, there is an improvement in the overall grades of the students. Whilst this is not proof of a maturing course format, it may indicate that, after fine tuning from 2005 to 2006, the presentation of the course materials is encouraging deep learning.

A project-based learning approach to protein biochemistry suitable for both face-to-face and distance education students

R.J. Prior, University of Canberra and J. Forwood, Charles Sturt University

Flexible learning approaches are being increasingly adopted within Universities to improve the learning outcomes for students. Online, distance and project-based learning are examples of teaching and learning methods that have gained popularity due to their ability to deliver course outcomes in a more flexible manner. At Charles Sturt University, students undertaking the degree of Bachelor of Biotechnology can study all subjects in either the face-to-face or distance education modes. Prior to 2006, one core second-year subject within the course, Protein Biochemistry, was delivered in a more "traditional" style to both cohorts of students. Face-to-face students were given didactic lectures on protein structure, function and analysis techniques, while distance education students were provided with a study guide, lecture notes, and a prescribed text. Laboratory practicals were also a component of the subject, completed by distance education students at an on-campus residential school. Both cohorts of students had access to an online subject page, where they could discuss subject material on a forum, and access learning resources such as tutorial worksheets. Students evaluated in 2003-2005 felt that this subject was difficult, were not able to see connections between different subject topics and frequently performed poorly in the subject examinations. Because of the nature of the assessment, which was 75% examination-based, students were also particularly focused on "what will be in the exam" rather than the subject material. In response to both staff and student feedback, alternative learning and teaching approaches were considered. In 2006, the project-based learning (PBL) pedagogy was implemented into both face-to-face and distance education modes, fully replacing traditional lectures, study guides and exams with a project-based curriculum. Here, we present a paper that describes the PBL approach used simultaneously in both face-to-face and distance education modes to teach Protein Biochemistry. A preliminary evaluation of the implementation of this approach is also included.

The persistence of students' alternative conceptions in wave propagation

A. Tongchai, K. Arayathanitkul, C. Soankwan, Mahidol University, Thailand

This research presents the persistence of students' conceptions between two groups of the students on the topic of wave propagation. The first group consists of 55 grade-12 students who had already learned mechanical waves by traditional teaching in school. The other consists of 83 grade-10 students who had never learned this topic. These two groups are at the same school. The research instrument used is a series of open-ended questions asking about basic concepts of wave propagation. The results show that students' alternative conceptions between these two groups are nearly identical. The most fundamental common alternative conceptions are:
(a) sound waves of higher frequency moves faster than those of lower frequency;
(b) sound waves of higher volume move faster because they have higher energy;
(c) waves with greater amplitudes have more energy, hence they move faster; and
(d) the speed of a wave on a string can be changed by changing hand movement.
These research findings will be a guide for the development of a conceptual diagnostic test on the topic of mechanical waves.