The role of the scientist-practitioner model in the teaching of psychology: preliminary results from the AUTC funded project *Learning Outcomes and Curriculum Development in Psychology*

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The Australian Universities Teaching Committee (AUTC) is committed to the identification of 'examples of best practice in teaching and learning in Australian universities at the level of discipline or field of study'. The AUTC funded project ***Learning Outcomes and Curriculum Development in Psychology*** was awarded this year to a team representing a diverse cross-section of Schools and Departments of Psychology in Australia. The project brief demands 'an evaluative overview of courses… with a focus on the specification and assessment of learning outcomes and must identify strategic directions for universities to enhance teaching and learning in these areas'. Although the final project outcomes will include a discussion of the teaching of psychology beyond that taking place within Schools and Departments of Psychology, this preliminary report will consider only information relevant to the teaching of psychology in core programs within Australian Psychological Society (APS) accredited academic organisational units (AOUs).

The project submission started with an assumption that the APS accreditation process plays a central role in curriculum design within the discipline. The current accreditation guidelines require academic AOUs to demonstrate (among other things) that a core sequence of teaching has taken place for all students in the degree, and that students have completed a significant piece of independent research as a component of their fourth year of study. These requirements follow from the general principle that the main focus of the undergraduate four-year degree in psychology should be the provision of a thorough understanding of the theoretical bases of the discipline and a capacity to understand and contribute to the growth of this knowledge base through empirical research. The development of significant practical skills is considered to be most appropriate for students in post-graduate training, where specialisation for membership of one of the Colleges of the APS (clinical, educational, organisational, etc.) takes place. This orientation to undergraduate education can be traced to the general acceptance of what is called the 'scientist-practitioner' model of training, which emerged in the United States following a conference of academic psychologists, the American Psychological Association and government stakeholders in Boulder during 1949 (Baker and Benjamin 2000; Barlow, Hayes and Nelson, 1985). The 'core value' of the scientist-practitioner model is that research and practice are deeply intertwined (Stricker, 2002) and that the practitioner must, therefore, be trained in the research practices of the discipline to the level of participation.

The project will bring together representation from Schools and Departments of Psychology in a 'Network Group' meeting in November of 2004. The Network Group will help us to validate the information already collected from web sites and individual schools concerning their courses. It is also hoped that this group will be able to provide insight into those informal processes within schools that have a bearing upon questions of curriculum development and innovative teaching practices. In preparation for this meeting, we have been interviewing nominees from psychology AOUs. These interviews provide information about the factors perceived to be important in curriculum design with respect to both content and implementation. The APS accreditation process, educational and psychological models of training, and individual views are all relevant dimensions about which we have elicited information.

The most striking feature of the information collected from Network Group members to date is the wide diversity of views held on almost all of the critical dimensions discussed above. Although there is a general consensus about the importance of the APS accreditation guidelines, on almost all other factors individual schools and departments differ widely. In some cases curriculum content and delivery have been influenced strongly by individual staff members, and in others the process has been strongly collegial and based upon shared principles. Differences between institutions in the presence of structures such as faculty and school teaching and learning committees, and in the degree of influence held over day-to-day teaching are quite marked. A number of nominees indicate budgetary constraints influencing some teaching processes, but the content of curricula is not generally perceived to be affected by either financial or staffing limitations. Technological innovation is taking place within Psychology AOUs that perceive such changes to be valuable on pedagogical or strategic grounds. However, we have not found any instances where real changes in delivery have come about through institutional pressure from above. Laboratory work and research training still play a substantial role in student learning experiences, but information technologies are being used to support and extend these processes in the face of increasing financial pressure.

One somewhat unexpected difference between institutions noted in the interviews conducted so far is in the degree to which the views (or at least the perceived views) of the State Registration Boards appear to influence curriculum decisions. It seems to be the case that some State Registration Boards are more influential than others. The level of influence appears to be related to the degree to which academic staff members are actively involved in the Registration Board. Registration Boards have usually been regarded as representing a somewhat more pragmatic, practitioner-oriented, view of training models. Thus it will be interesting to be able to compare institutions and their consensus positions on the scientist-practitioner model with respect to the level of engagement with their State Registration Board. These data will be available at the Network Group meeting. The Registration Boards are also becoming more closely involved in the accreditation process at the present time, making some discussion of their perspective on a range of issues quite critical.

References:

Baker, D.B. and Benjamin, L.T. (2000) The affirmation of the scientist-practitioner: A look back at Boulder. *American Psychologist,* **55**, 241-247.

Barlow, D.H. Hayes, S.C. and Nelson, R.O. (1985) *The scientist practitioner: research and accountability in clinical and educational settings*. NY: Pergamon Press.

Stricker, G. (2002). What is a scientist-practitioner anyway? *Journal of Clinical Psychology,* **58**, 1277-1283.

Laboratory-Based Teaching and Learning: Developing Quality Assurance Processes

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Students often indicate a preference for experiential learning methods (Boud, Cohen and Walker 1993; Boulton-Lewis 1994). Within the Chemistry curriculum, experiential learning is predominantly (but not restricted to) the laboratory practical exercise context. There are many purposes of laboratory-based teaching. Some aims are (Bennett and O'Neale 1998; Johnstone and Al-Shuaili 2001): to encourage accurate observations and careful recording; to promote simple, commonsense, scientific methods of thought; to develop manipulative skills; to give training in problem solving; to elucidate theoretical work so as to aid comprehension; to verify facts and principles already taught; to be an integral part of the process of finding facts by investigating and arriving at principles; to arouse and maintain interest in the subject; and to make phenomena more real through actual experience. Skills development encompasses; manipulative, observational, interpretative, and planning. This list may be aligned with the development of generic skills and graduate attributes that are critical for the post-tertiary success of university graduates. Laboratory-based learning is an ideal vehicle for developing: academic skills (critical thinking, problem solving, etc.); communication skills (written, oral, presentation); data handling (acquisitional, numerical, statistical); IT (data manipulation and presentation, report creation, research); self-management (time management, planning, reflection; and self-awareness) and interpersonal skills (teamwork, leadership).

If laboratory-based learning is considered fundamental to the student experience in Science education in general and in Chemistry in particular, then it might be assumed that laboratory-based learning is well aligned with students' preferred learning methods. Yet there is a considerable body of evidence to show that the potential of laboratory-based teaching and learning is not met, (Hart, Mulhall, Berry, Loughran and Gunstone 2000; Hodson 1990; and Watson 2000). Students often see the laboratory exercise as a task to be completed as quickly as possible, with the minimum possible effort (Edmondson and Novak 1993), and this attitude can defeat any attempts to use the experience as a teaching and learning tool. Students may not see the relevance of the laboratory exercise to either their coursework or anything beyond the unit of study in which they are undertaking the laboratory work. Unfortunately, there are rarely mechanisms in place to monitor the effectiveness of laboratory-based teaching and learning. That is to say, quality assurance procedures are lacking. What efforts have been made to analyse pedagogical content and embed monitoring schemes have generally met with limited success due to the constraints of limited time and limited expertise and experience in pedagogy. Thus, while laboratory-based teaching and learning is considered essential to the curriculum, little is actually known of its true effectiveness in action, and the research that has been conducted on it shows that it often does not produce the results that it is assumed to do.

Some of the known problems are:

- that students make few connections between their laboratory exercises and their coursework;
- student notes often have few, if any, explicit objectives, and typically across the curriculum they are fragmentary and inconsistent;
- staff retirements and movements result in the only extant documentation associated with the experiment being the student notes themselves; and
- guidance for demonstrators often does not extend beyond supplying the expected numerical answers, and rarely provides any indication of the learning outcomes that the students are expected to achieve, and how the demonstrators may help the students achieve them.

This project aims to raise the quality of laboratory-based learning experience of our students, and to establish methods for on-going maintenance, monitoring and improvement in laboratory-based teaching and learning within the Chemistry curriculum. This will be accomplished through the analysis and documentation of the pedagogical basis of the experiments used in teaching, and the provision of tools and methods to aid staff in using these experiments as effective teaching and learning objects.

An outcome will be a framework for the design and implementation of new teaching experiments and ethos of pedagogical awareness of laboratory-based teaching and learning amongst teaching staff. Development of generic skills and attributes by the students will be supported by identifying where in the laboratory program this development occurs, and by providing guidance to teachers for achieving that development.

This project aims to develop quality assurance processes by involving academic staff in a cycle of reflection upon their teaching practices in the laboratory program. A tool, the 'Educational Template', has been provided which supports this reflection with respect to individual experiments. By using this tool to articulate the intended learning outcomes and methods of achieving them, the quality of these experiments can be improved. More importantly, staff are able to identify the themes common over the whole laboratory program. Awareness of the issues associated with quality assurance in the laboratory program is raised through workshops, one-on-one discussions and working through the pedagogical analysis of the experiments. Departmental policy is formulated on the basis of the individual reflection and group discourse, ensuring that the staff develop a sense of ownership of the process.

References:

Bennett, S.W. and O'Neale, K. (1998) Skills Development and Practical Work in Chemistry. *University Chemistry Education* **2**(2), 58-62.

Boud, D., Cohen, R. and Walker, D. (1993) Understanding learning from experience. *Using Experience for Learning*. Buckingham, SRHE and The Open University Press**,** 1-17.

Boulton-Lewis, G. (1994). Tertiary Students' Knowledge of Their Own Learning and a SOLO Taxonomy. *Higher Education* **28**(3), 387-402.

Edmondson, K.M. and J.D. Novak (1993) The Interplay of Scientific Epistemological Views, Learning Strategies, and Attitudes of College Students. *Journal of Research in Science Teaching* **30**(6), 547-559.

Hart, C., Mulhall, P., Berry, A., Loughran, J. and Gunstone, R. (2000). What is the purpose of this experiment? Or can students learn something from doing experiments? *Journal of Research in Science Teaching* **37**(7), 655-675.

Hodson, D. (1990) A Critical Look at Practical Work in School Science. *School Science Review* **71**(256), 33-40.

Johnstone, A.H. and Al-Shuaili, A. (2001) Learning in the Laboratory; some thoughts from the literature. *University Chemistry Education* **5**, 41-50.

Watson, R. (2000) The Role of Practical Work. In M. Monk and J. Osborne (Eds) *Good Practices in Science Teaching: What Research Has to Say*. Buckingham, Open University Press.

Learning Statistics in First Year by Active Participating Students

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Abstract: *There has been a growing attention, especially in the last fifteen years on the teaching and learning aspects of statistics education (Chance 2000; Sowey 1998; 2001; Peiris 2002a,b). Although the knowledge, training and skills on statistics are welcomed by many employers, the majority of students still find statistics courses both challenging and unappealing. This paper reports on students' experience of learning statistics in a first year unit of study MATH1015: Statistics for Life Sciences at The University of Sydney. Following Reid (1997) who argued that a teacher's approach in a level environment can encourage student learning at a high level, the paper reports on the effects of small-scale curriculum change on students' levels of motivation and engagement with statistics. Drawing on Ramsden (1992), the paper argues for an approach to teaching and learning statistics in ways that are connected to students' experiences of the world.*

Introduction

The unit *Statistics for Life Sciences* at The University of Sydney is one of a number of junior statistics options that students enrolled in the Faculty of Science complete as part of the mathematics component of their course degree program. Students choose this unit on the basis of prerequisite knowledge in mathematics and usually those who have completed 2 units or less at the NSW HSC (or equivalent) are encouraged to pursue it. The *Statistics for Life Sciences* unit is about developing students' basic analytical skills related to statistics problems. Given the range of student interest and ability, together with the fact that many of these students do not intend to continue with any mathematics at the senior level, the challenge is always in how to keep students engaged in the possibilities of statistical literacy. Following Reid (1997), how might we create a learning environment that encourages and supports student learning?

In fact, anecdotal feedback suggests that many students do not develop this ability or interest at all throughout the duration of the semester-long unit, despite the importance of statistical skills and training for employability. One reason may be the continued persistence of what Prosser and Trigwell (1999) call a information transmission/teacher-focused approach to teaching, where the intention is to transfer information from the syllabus to students, with a teaching strategy where the teacher is the focal point. The converse of such an approach is an emphasis on the student as central, where the intention is to change the students' experience of the phenomena of their study. The need to understand how students' approach their learning in statistics seems central to the development of Prosser and Trigwell's (1999) conceptual change/student-focused approach to teaching.

This task has been taken up explicitly by Reid and Petocz (2001). Their focus on understanding the range of ways students' understand or experience their statistical learning is crucial then for informing teachers' curriculum-change interventions and their approaches to teaching. While Reid and Petocz (2001) argue that there are qualitative differences displayed by students' different conceptions of learning statistics to incorporate a deep approach – which are characterised by Ramsden (1992) in the following ways – as relating previous knowledge to new knowledge; as relating together knowledge from different courses and contexts; as relating theoretical/abstract ideas to experience and as the organisation and structure of a coherent conceptions, the main implication we want to draw out here is how we might design our teaching in order to shift whole. This is the learning context that we want to bring first year students into in the *Statistics for Life Sciences* unit.

Teaching and Learning in the *Statistics for Life Sciences* unit

The remainder of the paper describes a number of small-scale curriculum changes designed to engage students actively in their learning in *Statistics for Life Sciences unit*. These changes are best seen as a work-in-progress with ongoing evidence needed to provide evidence of its impact on learning and the sorts of outcomes students themselves describe. Firstly, I (Shelton) outline what I see as the 'classical approach' to teaching statistics and then I describe a new approach I have been using for the last 4 to 5 years based on my long term experience in higher education for more than 20 years.

The Classical Approach

Many elementary statistics courses cover the following topics: random experiments; data collection and summarising data in tables and diagrams; frequency distributions and typical shapes; mean and variance; introductory probability; basic probability rules and applications; some important discrete and continuous distributions; the binomial and normal distributions; sampling theory, the t distribution, statistical inference; goodness of fit tests and correlation; and regression.

One problem with the classical approach is the strict adherence to these topics as written in textbooks. In fact, it has been recognised that most textbooks are derived from the class notes of individual teachers. These textbooks may not satisfy the requirements of other teachers, in particular, through its style and presentation of material. In such cases, students are often guided by the preferred style of the teacher. Similarly, many textbooks do not provide for students' individual learning needs. A good survey of this problem can be found in Chatfield (1995), Rossman (1996) and Sowey (1998). Another problem with the classical approach is a tendency for 'Statistics driven by the Theory'. In this approach teachers explain statistical concepts primarily through mathematics—an appeal to abstraction. This may be suitable for mathematically oriented students but prove more problematic for students with less experience. For example, the concept of Probability is defined and developed using the theory of limits, and asymptotic results are studied including unbiasedness and consistency. There is little opportunity to move away from this type of heavy abstraction unless we critically reflect on the design of our learning environments and students' conceptions of learning statistics. In service units such as *Statistics for Life Sciences*, this theory driven approach seems to limit student engagement with the range of meanings and contexts for learning about the relevance and application of statistical knowledge for problem solving. If we are to take seriously the important place of statistics in the world, then this needs to be made clear to students in a variety of ways in order for them to develop personalised meanings of its purpose.

A new approach

It is clear that the emerging research into statistics education calls for a new approach to teaching and learning. Keeler and Steinhorst (1995) call for the use of small groups in the promotion of active learning. Yilmaz (1996) suggests that the ability to use statistics in context requires connecting problems to real world situations, knowledge of basic statistics concepts and the clear communication of statistical results. Along with Reid and Petocz (2002) conceptions of learning statistics, these aspects need to be accounted for in designing curriculum initiatives. To achieve this, the teacher must be knowledgeable, not only of the subject matter but also with the ideas about statistics students' bring to the classroom. In this way, the teacher can better support students' interest in and curiosity for the subject and show them how learning and understanding are important and useful in their career development.

The concepts of statistics developed below are based on 'randomness' or 'uncertainty'. Before beginning to teach a topic from the program, I take a real world example/application to demonstrate to students an application of this topic. In Table 1 we provide two examples of based on this approach.

Table 1. Examples of the classical and new approach to typical statistical concepts

Topic	**Classical approach**	**New approach**
Example 1: Linear regression	Define the correlation coefficient, properties of correlation, estimate the slope and intercept, residual analysis, model checking, prediction/forecasting	Take few examples of bivariate data, plot each data set, convince students various degree of association between variables, define a measure to find this association, explain the use of a suitable model, estimate parameters.
Example 2: Hypothesis testing	Define the null and alternative hypotheses, explain a test statistic, explain the P-value, power of the test, decision making	Consider a problem in the society. For example suppose that the government believes that 65% of the Australian people support their new environment policy. However, the main opposition party believes that this ratio is much below the 65% due to its long term effects of the proposed policy. Clearly there is a dispute between the two groups. How can we solve this dispute?

With the new approach in Example 1, the focus is on engaging students in inquiry. It is about putting data to use rather than students being passive recipients of abstract concepts. In Example 2, there is an attempt to demonstrate that statistics are useful in solving problems—in this case, a political context. The shift is a subtle one but an important one in rethinking the purpose of the unit overall. Students' experience of learning statistics this way has been largely positive. Witness their comments from end of semester feedback:

> Thank you for a great course and your support during this semester. I never thought I would understand statistics. Not only you did make it clear, interesting but it has been fun as well.

> Just want to let you know I enjoyed your Life Sciences Statistics lectures and tutorials last semester. I appreciated the classroom-style teaching and your understanding that many of us were not exactly math whizzes at school and/or, like myself, haven't done math for quite some time. Thank you for your patience and humour!

> The lectures were very clear and easy to understand with many real world examples and applications.

> The course notes were excellent and the pace of the course was perfect to all. The concepts are explained with real world examples which make the subject memorable.

This has been a small but significant change to the design of the *Statistics for Life Sciences* unit. While we note that student retention in the unit has been steadily increasing from 2001-2004, the next step will be to continue the emphasis on students' learning and the ways that a continued research agenda into their experiences can provide further understanding on the design of teaching and learning environments.

References

Chance, B. (2000) Components of statistical thinking and implications for instruction and assessment. *Proceedings of the American Educational Research Association*.

Chatfield, C. (1995) *Problem Solving: A Statistician's Guide*. Chapman and Hall. Keeler, C.M. and Steinhorst, R.K. (1995) Using Small Groups to Promote Active Learning in the Introductory Statistics Course: A Report from the Field. *Journal of Statistics Education,* **3**(2).

Peiris, M.S. (2002a) Teaching Mathematical Statistic, Scholarly Inquiry in Flexible Science Teaching and Learning, 2002, *UniServe Science Conference, UniServe Science*, (2002) 85-86.

Peiris, M.S. (2002b) A way of teaching statistics: An approach to flexible learning, *CAL-laborate*, **9**, 13-15.

Prosser, M. and Trigwell, K. (1997) *Understanding Learning and Teaching: the Experience in Higher Education*, London: Society of Research into Higher Education.

Ramsden, P. (1992) *Learning to Teach in Higher Education*. London & NY: Routledge

Reid, A. (1997) The hierarchical nature of meaning and the understanding of teaching and learning, Advancing International Perspectives, **20**, 626-631.

Reid, A,. and Petocz, P. (2001) Students Concepts of Statistics: A Phenomenographic Study. *Journal of Statistics Education*, **10**(2) 1-19.

Rossman, A. (1996) *Workshop Statistics: Discovery with Data*. Springer . (Companion Website: http://stats.dickinson.edu/math/Rossman/wshome.html).

Sowey, E. (1998) Statistics teaching and the textbook - An uneasy alliance. *Proceedings of the Fifth International Conference on Teaching Statistics, Singapore.*

Sowey, E. (2001) Striking Demonstrations in Teaching Statistics. *Journal of Statistics Education*, **9**(1).

Yilmaz, M.R. (1996) The Challenge of Teaching Statistics to Non-Specialists. *Journal of Statistics Education*, **4**(1).

A comparison of student usage of traditional verses ICT learning resources in the Life Sciences

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Introduction

Given the increased emphasis that tertiary institutions are placing on online learning, including its replacement of traditional modes of delivery, understanding how students use available resources can inform the way(s) in which online learning modules are constructed (or modified) and integrated into the curriculum. Examining how students use traditional and ICT (information and communications technology) resources available to them in their unit of study program allows tertiary educators to assess the role and effectiveness of each learning resource and whether resources are complementing each other within the unit of study curriculum.

Online learning modules and communications technologies are commonly used in the College of Science and Technology, The University of Sydney. In the Life Sciences, computer-based materials are used to simulate dissections, to direct laboratory-based experiments, to replace/supplement tutorials and to assist students to self-assess their learning outcomes. For academic staff, the introduction of online modules to support learning is appealing, particularly as these modules can be used to reinforce and/or replace elements within the curriculum.

Students taking first year Human Biology at The University of Sydney were surveyed in Semester 2, 2000, to determine how first year students use teaching resources (both ‘traditional’ and IT) available to them in the unit of study, and how effective they found these resources for learning (Franklin, Peat and Lewis 2002; Peat, Franklin, Lewis and Sims 2001a). The IT materials comprised non-compulsory tutorial modules and revision materials designed to support student learning. 20% of students did not use any IT or communications technologies to support their learning, even though they had access to computers and the Internet (Franklin et al. 2002). Within the subset of students who used the on-line learning materials, 90% ranked them as useful or extremely useful (on a five-point Likert scale).

To what extent should we be concerned that a significant group of students are not using IT learning resources? The provision of online resources can be costly and time-consuming and the assumption is that all students will benefit from their implementation. Peat, Franklin, Lewis and Sims (2001b) surveyed staff and student expectations of student IT usage and found that staff consistently over-estimated the use students would make of the computer-based resources. It should be expected that different students have different preferred modes of learning. Oliver and Omari (2001), for example, report that while many students saw value in learning on a web-based, student-centred, collaborative setting, many expressed a preference for learning in a teacher-directed mode.

The aim of the present study was to quantify the use of different teaching and learning resources in a mixed learning environment and evaluate whether students had different preferences for ICT and traditional modes of delivery to support specific aspects of their learning. We were interested in determining the extent to which students were using traditional learning resources, on-line modules and communications technologies, such as peer collaboration by email, and whether these differing resources were being used by students to learn new knowledge, to consolidate their knowledge, for exam revision and/or for personal interest.

Materials and Methods

We surveyed students in three intermediate (second year) units of study (Botany, Pharmacology and Zoology) within Faculty of Science degree programs at the end of Semester 2, 2002. The survey instrument asked students to indicate whether they use traditional and/or non-traditional learning resources and to specify the learning purpose for which each resource was used. Traditional resources included attendance at lectures, attendance at practical classes, personal lecture notes, practical notes, text books, library and collaboration with student peers. Non-traditional (ICT) resources included email contact with peers, web lecture notes, *WebCT* learning environment and computer-based tutorial modules. Students were not required to access all of these resources specifically but were encouraged to do so to supplement their learning. Certain tutorial computer modules were used in timetabled classes in Pharmacology and Zoology units of study. The categories of learning purpose offered were 'did not use', 'learning new knowledge', 'consolidating existing knowledge', 'background information', 'exam revision', and 'personal interest'. Students were asked to nominate all relevant categories.

The numbers of returned responses were n = 39 for PCOL2002 Pharmacology Fundamentals (26% return rate), n = 19 for BIOL2003 Plant Anatomy and Physiology (61% return rate) and n = 20 for BIOL2002 Animals B (26% return rate). Chi-squared analysis was used to determine if a significant number of students used a specific resource for specific learning purposes.

Results and Discussion

A comparison of traditional and ICT usage patterns, over the three cohorts, showed that students used traditional learning resources to a greater extent than they did ICT-based resources (Figure 1, with data in Appendix 1). The categories of learning for which there was a significant difference were acquiring new knowledge, background information, and personal interest. There was no significant difference between students' use of traditional *vs* ICT resources for consolidating existing knowledge and exam revision. Statistical analysis of differences between cohorts (Figure 1) indicated that Zoology students were not discriminating between traditional and ICT resources when it came to learning new knowledge; Zoology and Botany students were not discriminating between traditional and ICT resources when it came to using these resources for background information or for personal interest.

Traditional teaching modes (attendance at lectures and practical classes) were the major resources students used to learn new knowledge (Table 1, significant χ^2 values in Bold). This reflects, most likely, the traditional way most units of study are delivered at university level in the Life Sciences. Both traditional (personal lecture notes, practical notes, attendance at practical classes, peer collaboration) and ICT resources (emailing peers, *WebCT*, online learning modules) were identified as contributing factors in the consolidation of knowledge. There was no significant difference found between the usage of specific learning resources for the purpose of acquiring background information. The best resources for exam revision were personal lecture notes and online lecture notes, which were also used for personal interest along with the practical notes, *WebCT* learning environment and the online learning modules.

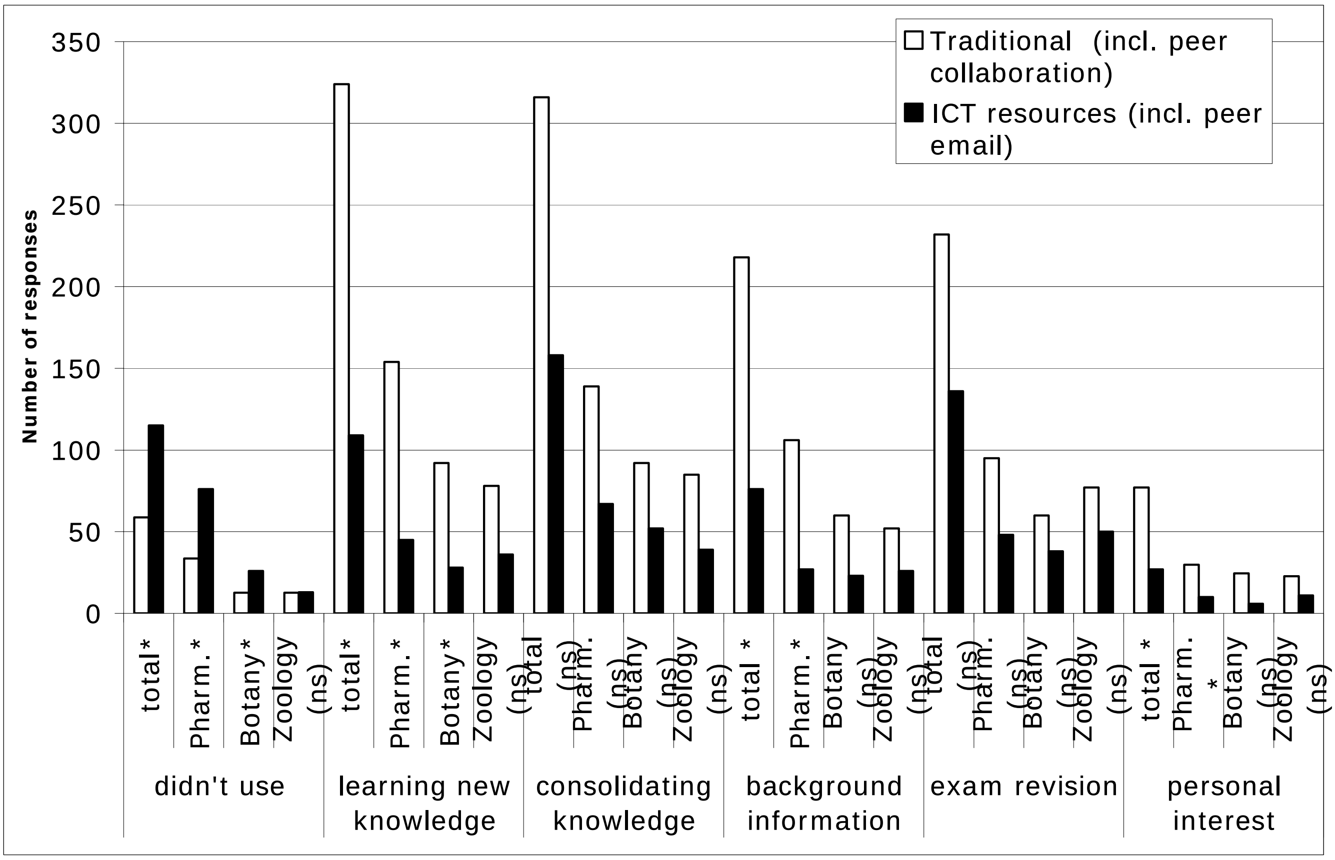

Figure 1. Numbers of students in Intermediate Life Sciences units of study that use traditional and ICT learning resources for specific learning purposes. For each category of learning purpose the total responses across the three unit of study cohorts, and the responses for each individual cohort, are plotted. The 'did not use' values are the sums of all 'did not use' responses within traditional (open) and ICT (closed) categories. Significant differences are indicated by an asterisk. (Critical $\chi 2 = 3.84$; df = 1; p = 0.05)

Table 1. Do students use specific learning resources equally for each learning purpose?

	Learning resource	learning new knowledge	consolidating knowledge	background information	exam revision	personal interest
Traditional resources	attendance at lectures	**39**	4	0	2	7
	attendance at practical classes	**10**	**10**	2	5	6
	personal lecture notes	2	**10**	5	**19**	**14**
	practical notes	0	**11**	0	0	**17**
	text books	1	1	0	0	9
	library	0	0	5	0	7
	collaboration with peers	7	**39**	8	1	4
ICT-based resources	email contact with peers for studying purposes	5	**25**	2	1	5
	web lecture notes	1	2	5	**13**	**16**
	WebCT learning environment	0	**13**	2	4	**20**
	biology content on the Internet	1	0	1	0	2
	computer-based tutorial modules	0	**13**	1	1	**16**

Values are the calculated χ^2 values for data across the three cohorts. Values in **Bold** indicate a significant usage of each specific resource for the specific learning purpose. (Critical $\chi^2 = 9.49$; df = 4; p = 0.05.)

Student peer collaboration was a significant factor that contributed to consolidating existing knowledge, but face-to-face peer contact was preferred over collaboration by email. Students used face-to-face peer collaboration (78% of all students) approximately twice as much as student email (46% of all students) to support their learning. This difference was significant for the learning category 'consolidating existing knowledge' ($\chi^2 = 8$, $p < 0.05$). The teaching environment in Life Sciences provides for high levels of student-student contact, as students spend extended periods of time working in groups (in practical classes), and our results could be a reflection of their familiarity with this particular learning style and environment.

A preference for 'live' peer collaboration is reflected by literature accounts of students' preference for face-to-face instruction from teachers rather than online instruction (e.g., Oliver and Omari 2001; Kenny 2003). While there appears to be a clear role for ICT in supporting student preparation for assessment tasks (examinations, assignments), students rate traditional modes of delivery more highly for the acquisition of new knowledge. Meanwhile, governing bodies and funding crises in universities argue for reducing face-to-face teaching time and increasing reliance on ICT-based delivery. If student satisfaction with courses is of any concern, our results suggest we proceed with caution in the current rush to get away from giving lectures. Instead, we should perhaps be orchestrating more opportunities in our curricula for students to participate in peer collaboration; it would be interesting to find out the existing mechanisms students use to collaborate and if new ICT could be introduced to better support this collaboration. It can be argued that such provision would enhance the vocational training of our graduates, as teamwork and collaboration aligns more closely with authentic practices of professional scientists.

Previous studies have related peer interactions to a variety of positive learning outcomes, e.g., students' academic achievement, development and satisfaction with their university experience (McInnis and James 1995; Krause, McInnis and Welle 2003). Twale and Sanders (1999) found the only non-classroom variable that was significantly correlated with critical thinking ability (as measured by the critical thinking section of the US Collegiate Assessment of Academic Proficiency Test) was hours spent outside class talking to peers about current issues. Even within a totally web-based learning environment, the amount of perceived human interaction with staff and peers was a strong predictor of student satisfaction with a course (Pérez-Prado and Thirunarayanan 2002).

Students in the present study used essentially non-ICT modes, such as lectures and practical classes, as the main mechanisms to learn new knowledge; however, in all units of study students were using computer tutorial modules and peer collaboration, as well as the traditional resources, to consolidate knowledge. The strategy of students appears to be incorporation of all means available to consolidate knowledge. This learning strategy seems to be linked primarily to the short-term goal of examination performance, rather than the more enduring motivator of personal interest. Indeed, Krause et al. (2003) reported that the most common reason for peer interaction between students at the University of Melbourne was to discuss assignments.

The current findings have implications for the designers of online learning resources, in terms of alignment between design objectives, student learning preference and staff expectation of student usage for all types of learning resources. If student learning preferences influence learning outcomes, as suggested by Franklin et al. (2002), then student preference for face-to-face rather than ICT learning resources should be taken into account when designing curricula. A variety of learning experiences that target different learning preferences need to be offered to enable a mix of traditional and non-traditional learning modes, including effective student interactions with peers as well as teachers.

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References

Franklin, S., Peat, M. and Lewis, A. (2002) Traditional versus computer-based dissections in enhancing learning in a tertiary setting: a student perspective. *Journal of Biological Education*, **36**(3), 124-29.

Kenny, J. (2003) Student perceptions of the use of online learning technology in their courses. *ultiBASE* March 2003 RMIT University. [Online] Available: http://ultibase.rmit.edu.au/Articles/march03/kenny2.htm [2004, August 20]

Krause, K.L., McInnis, C. and Welle, C. (2003) Out-of-class engagement in undergraduate Learning communities: the role and nature of peer interactions. Paper presented at the Annual Meeting of the Association for the Study of Higher Education (Portland, OR, November 13-16).

McInnis, C. and James, R. (1995) *First year on campus*. Canberra: AGPS.

Oliver, R and Omari, A. (2001) Student responses to collaborating and learning in a web-based environment. *Journal of Computer Assisted Learning,* **17**(1), 34-47.

Peat, M., Franklin, S., Lewis, A. and Sims, R. (2001a) Learning human biology: student views on the usefulness of IT materials in an integrated curriculum. *Australasian Journal of Educational Technology*, **18**(2), 255-274.

Peat, M., Franklin, S., Lewis, A. and Sims, R. (2001b) Staff and student views of the usefulness of information technology material within an integrated curriculum: are these educational resources effective in promoting student learning? In *Meeting at the Crossroads: Proceedings of the 18th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE),* 471-480.

Pérez-Prado, A. and Thirunarayanan, M.O. (2002) A qualitative comparison of online and classroom-based sections of a course: exploring student perceptions. *Educational Media International,* **39**(2), 195-202.

Twale, D. and Sanders, D.S. (1999) Impact of non-classroom experiences on critical thinking ability. *NASPA Journal*, **36**(2), 133-146.

Appendix

Table 2. Use of traditional and non-traditional (ICT) learning resources for specific learning purposes available to intermediate level students in Pharmacology (P), Botany (B), Zoology (Z). Data are % response (based on number of surveys returned per unit of study).

		did not use			learning new knowledge			consolidating knowledge			background information			exam revision			personal interest		
	Unit of study	**P**	**B**	**Z**	**P**	**B**	**Z**	**P**	**B**	**Z**	**P**	**B**	**Z**	**P**	**B**	**Z**	**P**	**B**	**Z**
traditional resources	attendance at lectures	3	0	0	**85**	**100**	**95**	26	32	35	33	53	50	36	26	35	**26**	16	30
	attendance at practical classes	0	0	0	46	**84**	**70**	67	47	65	33	37	15	8	32	45	21	11	**35**
	personal lecture notes	8	5	5	26	16	30	46	79	50	21	21	15	51	**79**	**70**	8	11	10
	practical notes	3	0	0	28	63	45	62	68	50	**46**	37	30	28	58	40	8	5	15
	text books	0	11	20	**67**	63	30	54	**74**	45	**49**	**53**	**55**	**59**	37	50	23	32	20
	library	46	11	5	13	63	40	10	63	50	23	**63**	**65**	18	21	50	5	26	20
	peer collaboration	**26**	**21**	**15**	13	11	10	**56**	**74**	**65**	5	16	15	26	32	50	13	11	20
ICT resources	email peers	**62**	**47**	**45**	3	5	5	23	58	25	5	11	5	10	16	25	3	5	5
	web lecture notes	5	21	0	**49**	32	**55**	41	63	45	23	16	25	**56**	**63**	**75**	**10**	11	10
	WebCT environment	44	11	0	15	**53**	40	44	63	50	8	32	30	18	58	65	0	0	5
	biology content on the Internet	59	42	10	21	16	35	13	21	25	10	32	45	8	32	25	8	**11**	**25**
	computer tutorial modules	26	16	10	28	42	45	**51**	**68**	**50**	23	32	25	31	32	60	5	5	10

Exam script analysis—A powerful tool for identifying misconceptions

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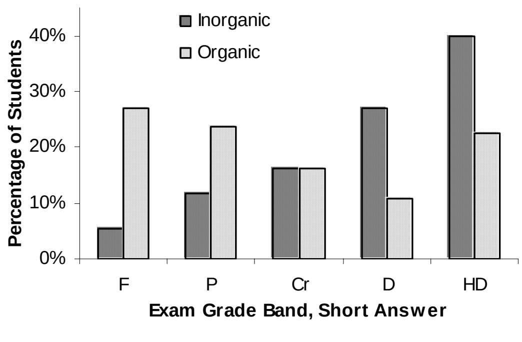
As part of a wider study of student understanding (Read, George, King and Masters 2004), a detailed analysis of the Semester 1, 2003 CHEM1405 (Chemistry 1 for Veterinary Science) examination was carried out. This analysis used both quantitative (statistical) and qualitative methods. Qualitative analysis focussed on evidence of misconceptions and commonalities in student approaches, both correct and incorrect. While university exams are primarily used for summative assessment purposes, this poster paper is intended to highlight some of the other information available from exam script analysis.

On the surface, the exam appears to have been an effective, if perhaps too easy, test for students in the CHEM1405 unit of study. Unscaled exam marks ranged from 30% to 95%, with a mean mark of 70.8% and a median of 73%. While there is some evidence of skew towards higher marks, the distribution remains approximately normal, with 68.8% of marks within one standard deviation of the mean, and 95.7% within two standard deviations. Beyond supporting the conclusion that the exam may have been too easy, and showing that it fulfilled its purpose as a summative assessment tool, these results are not terribly informative, and certainly do not tell the full story of the exam.

The exam itself can be divided into four approximately equally weighted sections—multiple choice and short answer questions in both general/inorganic (hereafter 'inorganic') and organic chemistry. Figure 1(a) shows the results from the short answer section, classified into exam grade bands, and Figure 1(b) shows the scatterplot of individual marks in the short answer sections.



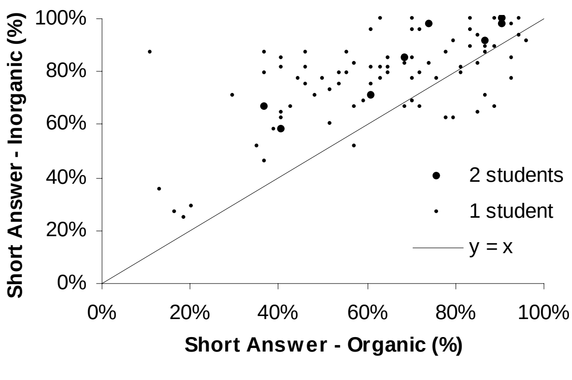


Figure 1. (a) Distribution of exam grade bands and (b) Scatterplot of marks in the short answer sections of the exam.

It is can be seen from Figure 1(a) that the marks are not normally distributed within the short answer sections, and that student performance in the inorganic section (modal HD) was considerably better than in the organic section (modal F). This is confirmed by the scatterplot, Figure 1(b), where the 95% confidence interval of the mean ratio of inorganic to organic (I:O) mark is 1.30 ± 0.08, after excluding the outlier (I:O = 7.88). In other words, students' scored on average about 30% more marks in the inorganic short answer section than they did in the organic short answer section.

Incorrect answers can also provide significant insight into the misconceptions held by students. Consider, for example, the multiple choice question: 'Which of the following elements is *unlikely* to be redox active in biological systems?' The options were (A) Li, (B) Fe, (C) V, (D) Mn, and (E) W.

Figure 2(a) shows the distribution of answers given for this question. In Figure 2(b), students have been classified by overall exam grade performance, and the rate at which the correct answer (A) was given by each group is shown. So, for example, of students who failed the exam none got this question correct, while 50% of students who scored HD (mark = 85+%) got the question correct.

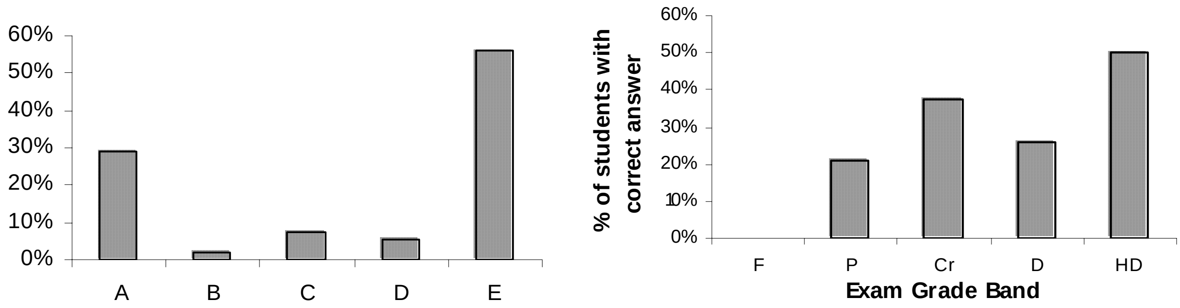


Figure 2. (a) Distribution of answers and (b) Rate of correct answer for the above multiple choice question.

It is clear that students systematically chose tungsten over lithium as the answer to this question, and that there was some weak correlation between performance on this question and overall performance. However, the popularity of the tungsten answer also points to the existence of misconceptions regarding the redox properties of both lithium and tungsten in a biological setting.

Questions on osmotic pressure and acid/base chemistry also pointed to misconceptions regarding these concepts. In the case of osmotic pressure, 76% of students could correctly calculate the osmotic pressure of a glucose solution, but 40% of this group could not report the answer correctly, offering a variety of incorrect units (e.g., atm L^{-1}, atm K^{-1} mol^{-1}, L K^{-1} mol^{-1} and even MJ mol^{-1}). In the case of acids and bases, 77% of students could correctly write equations showing what happens when acid or base is added to a named buffer system—suggesting a good understanding of buffers. Despite this fact, when asked to calculate the pH of an ascorbic acid solution (given K_a), more than half attempted to use the Henderson-Hasselbalch equation, which suggests that the understanding of buffers is much weaker than the marks on the buffer question would suggest.

One organic chemistry question asked about the amino acid cysteine (Cys) and Cys-Cys, its dipeptide. Amongst students who correctly drew the amino acid, 47% could not draw the dipeptide. Around half of this group offered answers which did not contain a peptide link, or did not conserve the molecular structure of Cys, or failed to follow bonding rules. These answers suggest that misconceptions persist in students' understanding of fundamental chemical principles, well beyond the area being directly examined in this question.

Analysis of exam scripts allows us to identify both problems with exam structure and misconceptions held by students. Knowledge in both of these areas can be used to guide improvements in future instructional courses, materials and assessment tools.

References

Read, J.R., George, A.V., King, M.M. and Masters, A.F. (2004) Students' perceptions of their understanding in Chemistry 1 for Veterinary Science. *Proceedings of the UniServe Science Symposium on the Scholarly Inquiry into Teaching and Learning*, Sydney: UniServe Science.

Finding the right words - a systematic approach to word selection for a special purpose science dictionary

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Background

First year undergraduate science students frequently report difficulties grappling with the technical and semi-technical vocabulary of academic science. Most first year science students undertake studies in several scientific disciplines (e.g., Biology, Chemistry, Geology, Physics etc.), each with their own set of technical vocabulary. Yet the students not only deal with specific and obvious jargon, but must also tackle more indirect jargon where commonly used words may have a different and special meaning in the scientific context (e.g., control, contract)

Inability to master scientific language represents 'a major barrier to learning' for a significant number of students (Wellington and Osborne 2001), or a 'lexical bar' to be overcome (Corson 1995). Such problems are exacerbated when the students come from non-English speaking backgrounds (NESB), whether they be local or international students.

Design

The 'Living Dictionary' is being developed by an interdisciplinary team of science educators and linguists to address this problem. It is designed as an online, searchable dictionary, with a sound-bite to give the Australian pronunciation for each word. This is important for NESB students who often cannot connect what is heard in lectures or practicals with the written version of the word. Students frequently report that this lack of connection severely hampers their comprehension of lectures and they often are embarrassed to seek help.

Each entry or headword has a simple, short, plain English definition, or, if the word has several meanings, a series of definitions (e.g., cell which has different meanings in general usage, in Biology and in Physics). The various forms of the word are listed (e.g. verb, noun, adjective etc.), as well as any antonyms. Examples of sentences which use the terms are extracted from the texts to show how the words can be used correctly. Where word combinations or phrases have specific meanings (e.g., messenger RNA), these are listed separately.

Word Selection

There are several subject-specific glossaries or dictionaries freely available to students on the internet, but the 'Living Dictionary' compilation differs because the word selection has been rigorously based on the student course materials, thereby ensuring relevance to these students. Moreover the definitions have been tailored to reflect the usage of the words in context.

Practical constraints limit the number of words to 3000. A basic proficiency in English is assumed and the first 2000 words from West's General Service List (West 1953) are thus excluded. However, we could not assume that all students would comprehend the core academic vocabulary to a sufficient depth, so half the words on the University Word List (UWL) will be included to give students a fairly broad basis to build upon. The University Word List (Xue and Nation 1984) was in fact developed from a concern with the reading abilities of tertiary level students, and built on the work of previous researchers such as Praninskas (1972) who shared these concerns. These researchers catalogued the most commonly used words in academic texts across a number of disciplines and compiled a frequency based list of some 835 word families. Words included in the first half of the UWL include acquire, analogy, consequent, fluctuate and inhibit.

Biology is the first completed segment, and words were selected from course materials of three different units (e.g., lecture notes and graphics). A master list of about 2000 words was compiled by experienced science educators, comprising all potentially difficult words and phrases, and the number of separate uses of the words was tracked and recorded. Any words that occur in the UWL or words used in several disciplines such as 'cycle' or 'subatomic' were removed to separate lists.

The final decision on which words to incorporate and which to cull was based on:

- frequency of usage i.e. how often the word was used in the course materials;
- how important the word is to clear understanding of key concepts; and
- teaching experience, isolating which words commonly cause problems to students.

Conclusions

The 'Living Dictionary' has the potential to be a powerful adjunct to student learning in first year undergraduate science. The mastery of technical and academic vocabulary is crucial to carry learners 'across the lexical threshold' (Cobb and Horst 2001) and thus to ensure successful learning experiences in science.

Plans for the future include the possible production of a hardcopy version of the dictionary. The online version will be used to track usage and thus assist in narrowing the selection to the most used words. This process will provide a rational and empirical basis for more selective hardcopy versions. The online dictionary also has the potential to facilitate further research into usage patterns.

References

Cobb, T.M. and Horst, M.E. (2001) Reading academic English: Carrying learners across the lexical threshold. In John Flowerdew and Matthew Peacock (Eds) *Research Perspectives on English for Academic Purposes*. London: Cambridge University Press.

Corson, D. (1995) *Using English Words*. Dordrecht: Kluwer Academic.

Praninskas, J. (1972) *American University Word List*. London: Longman.

Wellington, J.J. and Osborne, J. (2001) *Language and Literacy in Science Education*. Buckingham: Open University Press.

West, M. (1953) *A general service list of English words*. London: Longman, Green and Co.

Xue, G., and Nation, P. (1984) A university word list. *Language Learning and Communication*, **3**(2), 215-229.

Peer pressure and performance: meaningful team work

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The Bio2010 report by the US National Academy of Sciences (2003) recommends inquiry-based learning as a way of 'sharing the excitement of biology'. The report also encourages group projects and the use of current research problems. We have incorporated all these aspects into an intense course operating in the final year of our biotechnology degree. Our course is the last teaching Biotechnology students are exposed to, prior to their entering a work placement program. The goal of the course is to round off their degrees and utilize the generic skills they have acquired in a team exercise. The course is a full course but is scheduled for 5 weeks at the start of second semester. Thus it is an intense learning (and teaching) experience.

For the major assessment task the students are randomly placed in 'companies' and asked to address a problem. The problems are current biotechnological problems, predominantly in the area of reproduction. Each student has a unique role to play in the company, as well as participating in the team exercise. The intense learning experience rapidly builds teamwork. Peer pressure is seen in terms of meeting deadlines. A small peer evaluation component is used to help assess student contributions. Electronic feedback indicates that the course is well received. Students who make some contribution perform well and are aware of their contribution. There was a noticeably strong performance from students who had previously had completion issues.

References

National Academy of Sciences (2003) *Bio2010: transforming undergraduate education for future research biologists,* Washington DC, U.S.A: National Academies Press.

An investigative laboratory program in first year chemistry — experience and outcomes

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A new laboratory program in first year chemistry was introduced in 2003, initially for a class of 200 students, with the aim of fostering collaborative student-centred learning and critical thinking. In the laboratory, students worked in teams, providing input into the design of some experiments and, towards the end of session they undertook a short experimental project. At the same time, the tutorial program was redesigned in order to introduce open-ended questions or questions with no single correct answer.

The changes to the program were overwhelming successful, in that 78% of students reported the laboratory component to be either good, or the best thing about the course. While students found the new experimental approach challenging, and even frustrating at times, the tutorial modifications were less successful with 50% of students feeling that this section did not have the appropriate balance between conceptual and practical material. An important component of the change was to align the assessment with the goals of the new laboratory program. A higher proportion of marks were reallocated from lecture-based assessment to laboratory work, with some reduction in syllabus content. New assessment feedback sheets were designed to enable quality feedback to students and to enable demonstrators to provide consistent marks. This feedback mechanism has since been extended to other first year courses. The course was evaluated using an online student questionnaire, which allowed open comments, class visits and debriefing interviews with laboratory demonstrators and tutors. A number of further refinements have been identified, the most important of which are better structuring of tutorials and more support and training for demonstrators.

How do introductory psychology texts present science, and the scientist-practitioner model?

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The design of psychology programs in Australian universities is guided by the principles of the 'scientist-practitioner' model. According to this model, practicing psychologists are expected to be able to contribute to the creation of knowledge through research as well as utilising effective, evidence-based, procedures. Accreditation guidelines thus emphasise research-skills development throughout undergraduate psychology programs, and the importance of the honours-level fourth year as a capstone experience for Australian students. The AUTC-funded project, Learning Outcomes and Curriculum Development in Psychology, will provide an analysis of various sources of influence upon undergraduate curricula, curriculum design, and student outcomes. A starting point for this analysis is to examine how the scientist-practitioner model is portrayed within introductory psychology texts, which form the basis for students' understanding of the nature of psychology during their initial contact with the discipline. We will also be considering the treatment of the general nature of science in these texts, since the meaning of the phrase 'scientist-practitioner' is not clarified unless the meaning of the term 'scientist' is first known. The results of our initial survey of introductory texts will be provided, along with a description of our intentions to further.

AUTC Biotechnology Educators' Network

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There are more than two-dozen undergraduate degree programs in Australia in the relatively new area of biotechnology. Programs cover disciplines ranging from fundamental chemistry to ethics and intellectual property. The nature of these programs has been characterised by a national study funded by the Australian Universities Teaching Committee and conducted by principals at the University of Queensland, Flinders University, and the University of New South Wales. This effort has now moved into a second phase, which includes building a biotechnology educators network to share 'best practice' approaches to teaching biotechnology—from single teamwork assignments to industry placement schemes.

One challenge in building an educator's network in this new area is that there are many more lecturers who 'teach into' a biotechnology degree program than who call themselves 'biotechnology educators'. Nevertheless, all are welcome to our network. This conference session is meant as a network-building exercise for those of us who contribute to the education of students in biotechnology. The results of the national benchmarking study will be shared, and ideas for networking and network building will be entertained. The conference session then leads toward a national gathering of biotechnology educators coordinated by the AUTC Biotechnology team at the AusBiotech conference in Brisbane in November 2004.

The University of Newcastle's solution to the dwindling number of Science and Engineering students: Enlarge the pool

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Over the last decade there has been a well-documented reduction in enrolments in the science and engineering courses at the secondary tertiary levels of education. People have speculated about the causes of this disturbing international trend, however, up until now, no one has been successful in turning it around.

The University of Newcastle has developed two programs that, rather than trying to attract some of the small number of potential students to Newcastle, actually aims to increase the overall size of the pool of suitably qualified and enthused people. The initiatives are known as the *SMART* (Science, Mathematics And Real Technology) *program* and *The Science and Technology Challenge*. SMART is aimed mainly at infants and primary school age students. It uses interactive demonstration-based and multimedia science shows to inspire and engage young minds. *The Science Show Off!* Competition, a spin-off of the SMART program, provides a forum for school students to present their own science show to large public audiences. The Science and Engineering Challenge is a competitive workshop-style event for year 9 and 10 high school students. Teams are challenged to apply knowledge together with their own experience, creativity, teamwork and analytical skills to resolving realistic engineering and science problems.

There is a growing body of evidence that the programs are contributing to an increased enrolment in high school and university science courses. The University of Newcastle, for example, experienced 150 per cent increase in enrolments in Science degrees over the past two years and an increase in the University Admission Index for a Science degree from 67.5 to 70.1.

This poster overviews the rationale and structure of the programs, and how they both support and enhance the teaching of science. Initial research finding and plans for the future will also be presented.

Group projects in ecology foster a deep learning approach

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A third year offering in ecology at The University of Newcastle involved students working in small collaborative groups. Groups designed, conducted, interpreted and presented field-based projects addressing current ecological issues for local environmental management agencies. Communication and group/peer interaction was facilitated during the projects via face-to-face meetings, fieldwork, online group discussion forums and electronic file exchange facilities. Presentation of research findings was achieved via posters at a one-day symposium and an online virtual conference. Assessment of group projects was achieved via both inter and intra group peer assessment.

The activity has been designed based on Ramsden's (1999) principles of a student-centred approach to learning which aims to create a learning context which fosters a 'deep-approach' to learning. Indicators of a deep approach to student learning include an intention to understand, focusing on the concepts applicable to solving problems, empowerment of students to take an active and independent role in their own learning experiences, relating previous knowledge to new knowledge and an internal or intrinsic motivational emphasis.

Student feedback via a questionnaire and a series of open-ended written responses suggested that when provided with an appropriate face-to-face and electronic collaborative learning environment, student experiences reflect characteristics of a deep learning approach.

References

Ramsden, P. (1999) *Learning to Teach in Higher Education*. London: Routledge Press.