## AuPS/ASB Meeting - Newcastle 2007

## AuPS Symposium: Physiology education

Sunday 2 December 2007 – Concert Hall

Chair: Kirsten Farrand

## Developing research and inquiry though undergraduate education

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There is widespread advocacy for 'research-led learning' in Australia at present – especially amongst research intensive universities where it has proved to be an especially seductive idea. However, beneath the apparently shared vocabulary of the rhetoric, there is considerable variability in what students, teachers and university policy makers understand 'research-led learning' to be. For some it is about research led teaching - finding links between the research and teaching activities of staff, for some it is about promoting active student learning or a related idea of student engagement, and for others it is about the nature and quality of the learning outcomes – amongst many interpretations. Behind these variations in what the call to 'research led learning' is understood to mean, there is often some ambiguity as to the sorts of benefits that are assumed to flow from research led learning or teaching - and whom is expected to benefit. This seminar will consider these issues from the perspective of current research in the area of generic graduate attributes. It will explore how the need to foster certain sorts of student learning outcomes provides a pedagogically relevant rational for introducing research led learning with all undergraduates. There will be opportunities for participants to explore the implications this raises for introducing different sorts of 'research-led learning' in undergraduate curricula with diverse student cohorts.

## Models of research-led learning and the theoretical and practical considerations in diverse contexts

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How can teaching, learning and assessment of physiology be integrated to disciplinary research? In the experience of the School of Biomedical Sciences (UQ), there are distinct advantages to a systematic approach based on consensus models reflecting the priorities of physiology as a dynamic discipline, as well as the prioritised goals of course and program designers. These help (i) students to learn about physiology and learn through doing physiology that might be relevant preferably beyond the undergraduate years and (ii) teachers to assist student learning through appropriate course delivery and assessment. There is evidence available in the literature demonstrating (i) the connection between notions of scientific literacy (which frequently underpin the learning of science in school settings) and approaches to physiology which address the needs of large diverse classes (Laugksch, 2000) (ii) definitional challenges of how research and teaching can be integrated – do we really mean "research-based" learning? (Griffiths, 2004; Healey, 2005) and (iii) the link between research, teaching and inquiry based learning (Brew & Boud, 1995; Clarke, 1997). Examples of putting this theory into practice are illustrated by the Biohorizons eConference, an asynchronous assessment task in the large, foundation course - Human Biology (Moni *et al.*, 2007). Over 5-6 weeks, first-year students self-select into one of ten thematic work clusters. They work in pairs to write and upload a mini-paper on a detailed topic of Human Biology (entailing physiology) and a PowerPoint presentation. They are then individually assessed on the quality of questions and answers posted to their peers within their cluster. First, coded student opinion data support our course curriculum model which emphasises a balance of assessing knowledge, key manipulative laboratory skills, scientific reasoning to support inquiry, language use supported through effective student-student and student-teacher interactions. Details of this assessment task map to the curriculum model and to phases of inquiry based learning, thus demonstrating the usefulness of the model to explicitly frame learning, teaching and assessment (Moni & Moni, under review). Second, student opinion data from Biohorizons are used to define six ways in which this assessment task supports student diversity (Matthews *et al.*, 2007). It is argued that broad models can be made sufficiently flexible to address the needs of all students, irrespective of whether they are planning to pursue a path in physiology research.

Brew A and Boud D (1995) *Higher Education*, **29:**, 261-273.
Clarke BR (1997) *The Journal of Higher Education*, **68:** 241-255.
Griffiths R (2004) *Studies in Higher education*, **29:** 709-726.
Healey M (2005) *Journal of Geography in Higher Education,* **29:** 183-201.
Laugksch RC (2000) *Science Education*, **84:** 71-94.
Matthews KE, Moni RW & Moni KB (2007) Strategies for enhancing equity practices in the teaching, learning and assessment priorities of large first-year classes. EOPHEA 2007 Conference, Ethics and Equity: Re-evaluating social responsibility in education. 19-22 Nov, 2007.
Moni RW, Moni KB, Poronnik P & Lluka LJ (2007) *Biochemistry and Molecular Biology Education*, **35:** 255-265.

## Research skill development in practical course work: a cost benefit view

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Recent views of undergraduate teaching have suggested that teaching and research are inextricably linked (Brew, 2006). Brew argues that this goes beyond the lab-based practical component of many courses and a more integrated form of student engagement with research is to involve them with academics in inclusive communities of scholars. However, integration of a true research experience into undergraduate science curricula has often been viewed as impractical because of large class sizes or limited resources. In addition, since a large proportion of students will not progress to careers in research, one needs to be clear that the methodology for incorporating a research component is not unduly biased towards the comparatively small number who will. In this sense, the practical component should be aligned with desired graduate attributes, and truly serve the needs of all stakeholders.

The School of Molecular and Biomedical Science at the University of Adelaide was formed by the amalgamation of four pre-existing departments (Physiology, Microbiology and Immunology, Biochemistry, and Genetics). Each had their own approach to the integration of the practical research experience into the undergraduate curriculum, and these have mostly persisted in the School structure for third year undergraduate students. These range from students being placed in groups of 2 - 4 in a research laboratory and conducting an open-ended research project (Physiology) to working in a lab-based closed ended practical in a group of approximately 40, with supervision by a senior academic (Microbiology and Immunology). Biochemistry runs a hybrid model with a research-based practical for 80 students in groups of 8-10 held in a teaching laboratory. These various practicals generally run one afternoon per week, with other research related tasks interspersed.

The cost of running such practicals varies around $250 to $300 per student, but the calculation is complicated by the need to include the direct costs (*e.g.* lab supplies) as well as indirect (*e.g.* imposition on academic and/or laboratory head time for supervision). The relative proportion of these varies according to the approach taken. The different approaches appear to produce different recruitment rates into Honours and PhD programs (being highest for Physiology), but there may be other confounding factors at play. Surveys of the students exposed to the different approaches also reveal different alignments with graduate attributes of the different approaches.

Brew A. (2006) *Research and teaching: Beyond the divide*. Basingstoke, UK: Palgrave Macmillan.

## Creating the student-research nexus in research-led learning

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The paradigm of 'research-led learning' is interpreted in a variety of ways in different curriculum contexts. Commonly, research-led learning is equated with 'research-led teaching' – a process of exposing students to active researchers which is presumed to create an interpersonal research nexus. Alternatively, the student is perceived as the research-led learner, engaged in active (problem-solving) learning which involves hypothesis formulation and testing in a virtual or real laboratory.

In the teaching of cardiovascular physiology at the University of Melbourne, an alternative approach has been pursued which focuses on identifying research literacy as a primary outcome for undergraduate students. The subject is structured into three themes. For each theme a group activity is assessed which requires students to examine primary research literature and interact in developing a collective understanding. The first activity involves consideration of experimental findings which contradict an accepted dogma in the field. The second activity challenges the students to critique popular press interpretations of newly reported research, and provide alternative commentary for the benefit of their peers. To complete the third task, students debate the scientific, social and economic merit of research investment in controversial new therapeutic directions.

The research literacy level achieved by students depends on the nature of their academic investment in the process. For some students an understanding of how research provides the substrate from which text-book knowledge is synthesized is sufficient. For others, exploration of the difficulties of translating basic research findings into the public 'lay' domain offers a vehicle for a more sophisticated understanding of the research endeavour. For all students the opportunity to consider the practice of research (in particular biomedical research) as a subjective process with ethical dimension is enticing.

Thus, the student-research nexus takes on a different form, reflecting both student engagement and career trajectory. A multifaceted appreciation of what constitutes research literacy allows a flexible and student-tailored approach to research-led learning (and teaching).

## U.S. National Institutes of Health program: Fostering research at predominantly undergraduate institutions

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Sanford School of Medicine of the University of South Dakota is the lead research intensive institution hosting a partnership with predominantly undergraduate institutions and tribal colleges known as SD INBRE (funded by NIH). Goodman is the originator, principal investigator, and director of SD INBRE. SD INBRE has specific goals that include: 1) develop the research capacity of South Dakota in the area of the control of cell growth with special emphasis on proteomics and genomics and 2) develop human resources for undergraduate programs and graduate programs in the biomedical sciences and bioinformatics at South Dakota institutions by: a) providing research support and mentoring for junior investigators and faculty from participating institutions, b) providing opportunities for, and understanding of, cutting-edge scientific research for students at predominantly undergraduate institutions (PUIs), c) introducing undergraduates to graduate programs and future careers in biomedical sciences and bioinformatics, and d) enhancing science and research capabilities at tribal colleges to provide opportunities for further education and careers in science and research.

SD INBRE has been in partnership with Augustana College, Black Hills State University, and Sisseton Wahpeton College since 2001, added Dakota Wesleyan University, Mt. Marty College, and Oglala Lakota College as partners in 2004, and added University of Sioux Falls as a partner in 2006. Major progress has been made at the PUIs in building research infrastructure, changing the institutions to recognize and appreciate the research culture, supporting science faculty to conduct research either during the academic year or during the summer, providing research opportunities for undergraduate students in scientific research, introducing undergraduate students to potential future educational opportunities and careers in research, and enhancing the availability of scientific literature through shared library databases. During the summer of 2007, SD INBRE supported 59 undergraduate research fellows from the PUIs in their research experiences with faculty from their home institutions or from the host institution. The research network has been strengthened by encouraging camaraderie and collaborations among the faculty researchers by sharing seminar programs, gathering for travel to regional meetings on chartered buses, and visiting among institutions. In addition, each summer research experience for undergraduates begins with compliance training for use of humans and animals in research, laboratory and radiation safety, research ethics, and the goals of the program. During the summer, institutions sponsor weekly meetings among faculty and students to discuss their research. The culminating event for the summer is a convocation for all the undergraduate fellows with information about post-baccalaureate programs as a graduate fair, advice about interviewing for professional schools from both faculty interviewers and current students, a tour of the medical school research building, and a poster session with a reception honoring the fellows.