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## **“ARRGH” TO EUREKA: CHALLENGES FACING RURAL LECTURERS OF SCIENCE TO UNDERGRADUATE NURSES**

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### **Abstract**

This paper addresses some of the challenges faced by rural lecturers teaching human bioscience to pre-registration undergraduate nursing students. Rural nursing programmes attract large numbers of adult entry students who often have not completed Year 12 school study recently, if at all. Consequently they have often missed out on not only high school science curriculum but the higher cognitive skills developed in senior high school years. As a result of recognising the needs of these students an innovative tutoring programme for the first year bioscience subjects was developed to assist the knowledge acquisition of the students by enhancing implicit aspects of learning whilst still providing traditional tutoring methods. Activities were particularly designed to address the language and memory aspects of the factual components of the curriculum in active rather than passive tasks. Some of these tasks were based upon techniques for second language learning. Overall, the students appreciated the programme finding that active tasks assisted them in overcoming the science literacy component of their study better enabling them to progress their problem solving skills.

### **Introduction**

Dubbo is a rural township of approximately 40,000 people. For the Dubbo region the proportion of those people who have achieved tertiary qualifications is almost half that of metropolitan areas, 8.4% compared to 15.5% (AFFA, Map 41, 2004). However, people who have vocational qualifications exceed the numbers for metropolitan areas, 13.9% compared to 11.5% (AFFA, Map 43, 2004). The Dubbo campus serves an area north to the NSW border, west to Broken Hill and south to Parkes, however rural students are now coming from all over the state.

Colleagues at this rural university campus, by survey, profiled the past and present nursing student cohort and found that the intakes since the nursing programme's inception were largely first-generation university students. Of the students surveyed 21% had left school at 15 years old. This had been expected as the geographic location of this campus was partially founded on census statistics that had revealed a lack of university graduates in the region. The study also

found our students were not likely to be high school leavers, with fewer than 11% being under the age of 20 years, almost half had children living with them and only half completed high school to Year 12 (17-18 years of age). In fact, 26% of our students were older than 35 years (Maginnis, Croxon, 2004). These figures contrast with the national figures reported in National Nursing Review where mature age entry was estimated as 9% of all students with only 37% having completed their final year of school (Heath, 2002).

University entry for these students is based on recognised prior learning other than high school studies. Classroom discussions with the students revealed a very mixed background regarding science subjects. Most, if they had completed high school, had studied biology but few had attempted chemistry or physics. A lack of university entry level science literacy creates high levels of stress for the student in introductory classes. It has been noted in the published literature that approximately 21% of undergraduate nursing curricula is devoted to the biomedical sciences and that nursing education follows the body-systems approach to illness despite illness being a bio-psychosocial circumstance (Brown, Seddon, 1996). Consequently nursing education and practice relies heavily on knowledge of anatomy and physiology. Physiology understanding requires a certain level of chemistry literacy as does pharmacology, nutrition, microbiology and pathophysiology. The bioscience programme developed at this university includes anatomy and physiology, microbiology, pharmacology, introductory chemistry and physics spaced over two years as support for the nursing subjects. The qualitative research in the literature concerning lecturers' options regarding previous science literacy upon university entry highlights the fact that many feel the need to reduce the levels of subject content in order that students cope (Brown, Seddon, 1996).

This circumstance is not unique to Dubbo. Students enrolled in the Environmental Studies programmes at Southern Cross University (SCU), which has no specific prerequisite subjects for entry, noted great differences in academic backgrounds and associated prior learning of their students. Those who had studied general science at high school comprised 40% of the successive cohorts, a further 30% had specialised in a higher grade science. Like the Dubbo nursing programme cohort, of the SCU students 20% had not studied high school science and 50% were not immediate high school leavers (Boyd, Cullen, Bass, Pittman, Regan, 1998). Gresty and Cotton (2003) have noted student intakes with varied levels of experience in the biosciences in the UK and the anxiety this creates for the students who recognise that an understanding of biology in particular is important for their nursing practice. It is recognised throughout the academic literature that previous experience of the biological sciences impacts positively upon success at university level study (Wharrad, Allcock, Chapple, 1994, Jordan, Davies & Green, 1999, McKee, 2002, Peat, Franklin, Devlin & Charles, 2005).

The effectiveness of enabling or bridging programmes has been assessed showing that such programmes do provide some level of equity for students arriving at university with varied levels of previous education rather than through traditional entrance pathways. Assessment of these programmes demonstrated that students who participated in them increased their self-efficacy, and in turn, increased their confidence when attempting difficult concepts, thus alleviating some of their anxiety (Cantwell, Bourke, Archer, 1997). Charles Sturt University (CSU) provides preparation courses for students and provides study skills advisors. A preparatory residential school in chemistry and physics especially designed for nursing students operates at the Bathurst Campus prior the university semester. The Dubbo cohort does not have a high attendance record for this opportunity. The reasons given by the students when informally surveyed included: the expense of staying away from home (accommodation and child care – particularly given the on-going drought being experienced in Australia that is now

in its eighth year); inopportune time to leave the farm or the family for a continuous period of time. Distance education packages are available as non-credit subjects in chemistry and physics but they are written for science students entering a science programme. One mature age student has attempted the chemistry package finding it too difficult to attempt without tutors (*personal communication*). These packages also attract a cost other than accommodation for the residential school.

A tutoring programme was designed in an attempt to meet the apparent needs of the students lacking a science background and encourage them to avoid surface learning techniques. In light of the literature this paper looks at how learning might be improved and how related stresses might be decreased through active use of study tools and the potential for self-assessment for those student cohorts in subjects where specific subject background aspects of literacy are not the same. The paper reviews how students might be encouraged to create their own study and self-assessment tools; how depth of learning might be enhanced and thus the ability to problem-solve; and how adoption of such a programme might encourage the students to take more responsibility for their own learning, thus enhancing the possibilities for life-long learning.

## **Research methodology**

Two literature reviews were undertaken to explore, firstly, the recent research in 'how we learn' such that the findings might be applied to the tutorial classroom; secondly, to explore the potential benefits and approaches used by others to enhance students' study abilities. The reviews were largely restricted to the science classroom. However, texts concerning cognition and the psychology of learning were also accessed. Journal databases that were searched included CINAHL, Current Contents, PSYCHINFO, Informit, Google Scholar and ERIC.

The resultant techniques developed were trialled with first year students and the results presented here are those based upon the two lecturers' process of reflective practice.

## **Literature Reviews**

### *Issues to consider for the tutorial design.*

Chalmers and Fuller (1996) clarify the point that problem solving and critical analysis cannot successfully take place without a sound knowledge base. Surface approaches to learning do not provide for such a knowledge base, yet it is recognised that tackling completely unfamiliar content can result in surface learning approaches being adopted by the student as they endeavour to 'catch-up' (Boud, Cohen, Sampson, 1999). Up to 5,000 terms and phrases have been identified as necessary for 'cultural literacy' in science (Laugksch, 1999). This is thought to be the level reached by most educated adults that believe themselves literate in the sciences. The next level of literacy in science is referred to as 'functional scientific literacy' where the person possesses a lexicon to read, write and converse in a meaningful way. Those with 'true scientific literacy' are involved in scientific investigation and reasoning. Cultural literacy requires a shared level of knowledge for effective communication (Laugksch, 1999).

Boyd, Cullen, Bass, Pittman and Regan (1998) investigated levels of numeracy and literacy for students entering environmental studies programmes which requires no prerequisites subjects

for entry. The CSU Nursing programme also has no specific prerequisite subjects other than English for entry. These authors noted the marked variation in educational backgrounds of their students due to recognised prior learning being a component of the criteria for entry. They interpreted this as reflecting the change towards 'programme-driven' degree course as differentiated from the traditional discipline-based or liberal arts types of study. Apart from indicating that the CSU Dubbo Campus is not in a unique position regarding its student cohorts, it implies that entering students are far from a homogenous group in terms of education levels. Educators are taught to vary lessons to accommodate different styles of learning but curriculum documents tend not to allow for varied levels of entry. The recognition of prior learning does not indicate the quality or intensity of that experience. Brookfield (1995) notes that "...experience should not be thought of as an objectively neutral phenomenon ... experience is culturally framed and shaped." Such variation places the educator in a position of being unable to assume any level of prior experience of the sciences. The distinctions made between adult and adolescent learning theories may be of less significance than previous life and educational experiences. Learning patterns, cognitive style, culture and differences in class may have had more of an impact (Brookfield, 1999).

Of interest are the results of Regan and Regan (1995) who studied differences to study approaches of first year university students. They found that males were considerably less organised and most likely to adopt surface learning strategies when compared to female students. They also noted that mature age students preferentially adopted deep learning strategies compared to younger students. Yet, this study also found that the nursing students were most likely to adopt surface learning techniques. This result seems contradictory. Heath (2002) in the National Nursing Review noted that 88% of students entering nursing are female and on the Dubbo campus many are mature age entrants which emphasises the need for quality teaching and tutorial time spent with these students. The contradiction may be the result of the perception of nursing as having its professional foundations in 'care' rather than having an equal footing in 'science'.

Five basic modes of learning have been identified by Collis and Biggs (1991) the sensori-motor associated with tactile skills; the iconic in which imaging plays a significant role; the concrete-symbolic based in written language or forms of symbolic notation such as music; formal which involves the use of theoretical models; and post-formal are those able to challenge basic foundations of a discipline. The formal mode is that which is reinforced at high school after the age of 16 years enabling the adolescent to develop hypothesis. Collis and Biggs strongly suggest "that a bachelors degree requires a high level of functioning in this mode in the student's major study areas as a minimum passing standard". These authors indicate that in the science classroom.... "a multistructural level of functioning in school science implies that the students: know about how some things work; have learnt some basic scientific facts; can perform some simple experiments following step-by-step guidelines and can note relationships between variables". However, students entering university science subjects, other than from school, will be disadvantaged by having missed this developmental stage of their formal learning unless they have been exposed in other studies.

The use of technical language can marginalise those not previously exposed and effectively disempowers the learner. Students learn approximately 15% of unfamiliar words encountered in a normal reading cycle - thus, they need to learn how to read a technical text (Swanborn, Glopper, 1999). An awareness of phonetic structure helps fluency and determines oral reading rates that affect comprehension (Johnson, Layng, 1992). Research by Biggs and Telfer cited in Edwards (1999) indicate that exposure to totally foreign material can be so overwhelming that

the student fails to learn. Learning may also not take place when the learner does little to interact with the material to cause its recoding in memory. This follows the cognitive theory of learning from psychology where 'rehearsal and encoding' determines the level of long-term learning and whether it is surface learning or deep learning. Rehearsal relies on memorisation, a rote component, where learning is through repetition of material. Encoding requires usage of the material and linking to previous knowledge thus it is remembered with inherent meaning and thus for longer.

A lack of conceptual understanding can lead to the adoption of superficial learning patterns, particularly when literacy is poor - the student memorises instead of engaging with the material, preventing them gaining conceptual understanding and so they do not progress. This is compounded by students' ineffectively searching for material. That is, if a question does not contain the keyword for the necessary search, the student fails to find the required information - whether from library catalogue, text or database (Dreher, Brown, 1993).

Brookfield (1995) notes that nearly every text concerning adult education reinforces the need for educators to provide experiential learning opportunities. One study combined adult learning models under four headings: Structure of Learning experiences; Learning Climate; Focus on Learning; Teaching-Learning Strategies and Media. Essentially, these four groupings provide a synthesis of characteristics that include – adults prefer face-to-face teaching and interactional activities; they derive the most from clear instructions and expectations and activities that assist them to process their experiences (Stroot, Keil, Stedman, Lohr, Faust, Schincariol-Randell, Sullivan, Czerniak, Kuchcinski, Orel, Richter, 1998). Opportunities for learning practical skills will motivate these learners and they benefit from active participation.

Peat, Franklin, Devlin and Charles (2005) created an online and paper based support structure for students entering first year university biology. Previous education levels were varied and the cohort consisted of students from different schools. Crosswords and weekly self-tests were provided in class for completion at home, as was a mid-semester test, as self-assessment tasks. Answers were provided online. A biology CDROM and a Virtual Laboratory provided visual study support. The tools failed to benefit the students in first semester although the researchers measured an impact for second semester. This result was attributed to the transition phase of university entry. It may also be a result of scientific literacy levels at entry. The authors noted that those students in the group that were remaining as biology students rather than nursing or pharmacy made more successful use of the tools provided. Another aspect may be the need identified by Boud (2000) and others that self-assessment needs to be taught for its value to be recognised.

## **Results, analysis and discussions**

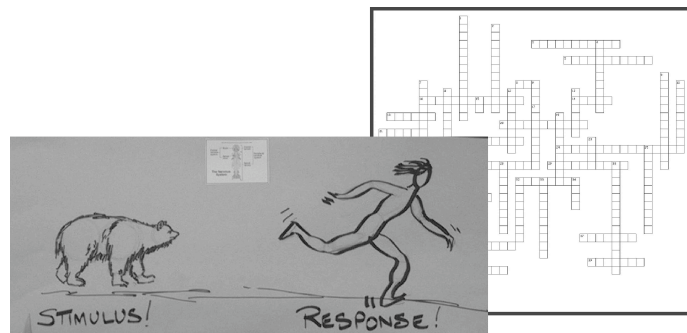
The literature review information supplied more than just 'tricks' to assist the students. This information gave a better understanding of the stages of mental ability the students might have developed towards prior their university enrolment. The many theories of adult learning assist to some degree, however, not all the students fitted a particular model possibly because of the very broad range in ages in the cohorts. What could be addressed in the tutorials was the science literacy levels in a variety of ways that stimulated the various student learning styles. By addressing this aspect in the classroom, the face-to-face and participation in learning aspects delineated as part of the adult learning theories could be maximised. The other aspect that was



important in terms of adult learning theories was that the tutorial classroom had to become a safe place to express 'the silly question'. Students commence studying science often with the perception that science is an accumulated set of indisputable facts representing discrete aspects of the world which they have to learn. This may well be true of achieving a usable science lexicon but is far from 'truth' when studying scientific concepts as shifts and changes move to accommodate the growth in knowledge. The aim in tutorial class was to advance the students in aspects of word usage so that studying new knowledge and concepts became less difficult, and problem solving became less cause for anxiety as the students were more able to use the resources available. Those resources included Online class forums, textbooks, CDROMs that included visual graphics and encouraging the students to develop and utilise means of self-testing.

Tutorial tasks were accomplished in small groups of three or four students. A conscious effort was made by the tutors always to find the positive aspect in any answer given by a student so that tutorial classrooms did not generate any negative associations. The tasks were designed to make use of what might be learned implicitly as well as actively and explicitly. This meant the classroom was rarely quiet as the students were either working on their feet or discussion of possibilities. All the tasks were designed to stimulate auditory, visual or kinaesthetic memory (See Figure 1). Tasks involved puzzles created from lecture overheads, crosswords to solve or to create the clues for, and poems that used analogies of common life experience to explain biological function that were read aloud. Readings might leave words out for the group to fill in but the omitted word was not the target word to be learnt, rather a word of connection. This caused everyone in the group to attempt pronouncing the unfamiliar word in context. The idea behind these activities was to make the available resources, especially the textbook, more accessible to those who were completely unfamiliar with the language being used. Diagrams and other puzzles that had been reconstructed in class were placed onto the classroom walls for further reference. This made them available for problem solving exercises and, since overheads during lectures are always changing, provided some continuity between overheads in lectures and lecture sessions. The classroom walls became a visual reminder, something like a storyboard for each module of important concepts and points of reference. The process of doing these exercises in the classroom rather than as extra opportunities to be used at home meant that nobody could avoid the tasks and 'get left behind'. It resulted in the students being able to more effectively study at home in away that provided a depth of learning rather than the surface method of memorisation without understanding, as a certain level of literacy had been achieved in class by the group in advance of the more serious process of preparing for formal assessment tasks.

Students have access to previous years' exams via the library. To encourage the students to access them, the questions were turned into overhead slides for a team quiz session where the prizes consisted of chocolate for correct answers, or even partial correct answers. This gave students the opportunity to determine where they were up to in their exam preparation and how much work they still needed to do whilst making sure they had all experienced the exam format. As this activity came at the end of semester the class membership knew each other well (courtesy of the previous tutorial and laboratory activities) so the exercise provided both light relief and a learning experience. It also occasionally highlighted alternate meanings possible for exam questions, a worthy exercise in that these were students of nursing and their practice lexicon was that of becoming socialised into the culture of nursing not science.



*In our town, we are surrounded by the wall  
The **lipid bilayer** we all call  
Within this we have various factories  
Ranging from power plants to actuaries*

*The infrastructure of this powered town  
Runs on **cytosol** for transport to abound  
The **mitochondrion** gives the cell its power  
For **chromatin** to socialise for a good hour*

**Figure 1. Brief examples of tutorial tools.**

Generally, subject marks were seen to improve by varying degrees. Those students who had some level of background in biology found the tutorials frustrating, as this approach was not what they expected at university. Yet these students overall marks also improved. However, those students who arrived without a background in science appreciated the approach as it fulfilled its aim of making the resources more accessible. They discovered that their textbook was less difficult to read and so persevered. These students continue to ask for more.

Students are encouraged from the outset of the subject to form small study groups for the opportunity they provide for peer learning. Some groups have turned lecture overheads into flash cards for self-testing. Student initiatives such as this combined with using the types of tools being provided in tutorial as self-assessment tools might improve the confidence level with which the students approached their exams. If the students themselves initiated the design of the tools in class then the meta-cognition required would further facilitate long-term memory. This provides the students with a means of actively assessing their learning as they studied in forms that supported their own learning styles. The group nature of the activities supported the peer learning aspects and the process of encoding the material for in-depth learning.

The process of reflection led the authors to consider ways in which self-assessment might be encouraged. The study by Peat, Franklin, Devlin and Charles (2005) at the University of Sydney indicated that passive availability to study tools and formative self-assessment tools did not effectively encourage their use in the first semester of university study. Boud (2000) notes that formative self-assessment must be taught and that students need involvement in their design and require feedback. Using the study tools in tutorial class provided immediate feedback and the opportunity to monitor levels of quality for the materials being produced. As the classes are largely made up of adult entry, first generation, university students the academics cannot assume that students have a concept of what level of learning quality needs to be attained despite the students having copies of the subject objectives.

The process of creating the tools, that then might be used as self-assessment tools, may prove an effective way to instruct students to recognise cues from textbooks and lecture notes for information encoding. Since the students would be creating their own tools the analogies used would be from their individual experiences, not just those of the tutors, providing a richer diversity of tools to be exploited by them and their classmates. At such an early stage in their academic careers, the content volume of new knowledge in science subjects tends to overwhelm and create anxiety. The tutorials, as a time to create self-study and self-assessment tools, provide the students with a specified time to address the causes of this anxiety by literally breaking down the content into smaller pieces of a larger puzzle. The problem solving exercise is one of creating the puzzle from which to study effectively. The process becomes transferable to problems that actually involve the content to be learned, or for that matter, to another subject.

In future, it is envisaged that the original tutorial programme will be more student centred with the students using the tools the tutors have created as examples and then creating their own which are then shared. More proactive students have already begun this process for their personal study. The tools then serve as self-assessment and peer-assessment items to assist self-study and group study sessions. Such a variety of study tools would stimulate a variety of learning styles. The process should encourage team formation and empathy for others' skills. It should also empower the students as the creative process requires the tutor only in the capacity of maintaining the level of academic content, therefore putting the students in a position of greater responsibility for their own learning. As students would be actively taught from week one of university entry to design and use study tools and to self-assess, then they would learn very early in their academic career the value of reflection and self-evaluation. The development of the tutorial tasks took a considerable amount of time on top of the usual academic workload however, once developed they continue to be used and the ways in which each item is used varies with the student cohort as they add to the library of tools and students begin to develop their own tools.

## **Conclusion**

Passive availability of tools to enhance depth of learning have been shown by other authors to be ineffectively used by the students. This tutorial programme has demonstrated that active use of tutorial and study tools in the classroom, despite it being university level study, can prove worthwhile in combating deficiencies in science background for students entering university based upon recognised prior learning not associated with science education. The process has demonstrated that active engagement and creation of study tools within the classroom results in students commencing good habits of study from week one of university of entry and helps them overcome some of the associated anxiety that can cause them to adopt surface learning strategies. The students continue to ask the lecturers for more.



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