TARGETING THE BIOSCIENCE-PRACTICE NEXUS TO FACILITATE LEARNING IN FIRST YEAR NURSING STUDENTS

Suzanne Evans, Charles Berry, Karen Mate

Presenting Author: Karen Mate (Karen.Mate@newcastle.edu.au)
School of Biomedical Sciences and Pharmacy, University of Newcastle, NSW, 2308, Australia

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ABSTRACT

A sound understanding of bioscience and an ability to use knowledge in solving complex problems are required for proficient nursing practice. This paper describes the continuing development of a bioscience course designed specifically to engender these attributes in first year nursing students. Face to face teaching hours were divided equally between lectures (to introduce the topic to inexperienced learners) and problem based interactive tutorials (to teach the skill of applying knowledge of basic scientific concepts to clinical case scenarios). The difficulty of finding sufficient teaching staff with a strong scientific and clinical background was addressed by using a large group interactive format for tutorials, without any negative impact on the perceived level of support provided to students.

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BACKGROUND

Effective nursing practice requires a complex skill set, drawn from the social, behavioural and biomedical sciences. Although the relative importance of these areas has been the subject of much discussion, it is essential that nurses acquire and maintain a sound knowledge base in the biosciences (including anatomy, physiology, biochemistry, immunology, pharmacology, genetics and microbiology) to function optimally in the technical and rapidly evolving modern health care system (Clarke, 1995; Torrance & Jordan, 1995; Clancy McVicar, & Bird, 2000).

Nurses are expected to work both collaboratively as part of an interdisciplinary team but also with an increasing degree of autonomy to make complex decisions about patient care. In order to be credible team members who contribute effectively to the collaborative working environment, nurses require a basic scientific literacy and the ability to understand and communicate bioscience issues to colleagues (Prowse & Heath, 2005). The increasing autonomy of nurses, and the expansion of their traditional roles to nurse practitioners and prescribers, requires a sound understanding of the biosciences as the basis for their clinical practice. With recent recommendations to embed research and evidence-based healthcare into the Australian health care system (Department of Health & Ageing, 2013), there will be an increasing need for all health professionals including nurses to develop an appreciation of scientific research and its basic principles. Despite its importance, the integration of biosciences and basic scientific skills into crowded nursing curricula remains challenging for both staff and students.

BIOSCIENCE IN THE NURSING CURRICULUM

There is no explicit statement regarding the amount or level of bioscience required as part of an accredited program of study for registered nurses in Australia, apart from a specific requirement for “appraisal of competence in pharmacokinetics, pharmacodynamics and quality use of medicines’ (Australian Nursing and Midwifery Council, 2012). Likewise the National Competency Standards for the Registered Nurse (Australian Nursing and Midwifery Council, 2006) requires nurses to maintain “a current knowledge” and to possess critical thinking and analysis skills in relation to evidence based practice, but makes no specific mention of bioscience. Interpretation of these standards based on a holistic model of health care, has largely lead to the inclusion of all aspects of health and well-being into Australian undergraduate nursing degree programs. A web-based survey of the undergraduate nursing programs offered by 32 Australian universities found that bioscience is taught as a first-year foundation subject in most programs, but the time dedicated to the subject varies substantially, from minimal to 25% of first year. This variation may be related, in part, to the academic and professional background of teaching staff, which has been found to affect their views on the role and relevance of

bioscience to the nursing curriculum e.g. staff with a Registered Mental nurse qualification were more likely to be in favour of reduction or abolition of biosciences whereas non-nurses with a bioscience background advocated for an increase in bioscience content (Davies, Murphy, & Jordan, 2000).

STUDENT ATTITUDES AND DIFFICULTIES

Nursing students appreciate that bioscience is a key contributor to nursing knowledge, and that application of this knowledge to their practice improves patient care (Smales, 2010; Craft, Hudson, Plenderleith, Wirihana, & Gordon, 2012). A survey of New Zealand nursing students found that 81% thought that there was insufficient bioscience in their nursing program, although many commenced their studies feeling underprepared in this area (Friedel & Treagust, 2005). Bioscience is perceived as more difficult to understand than other nursing subjects, is often a source of anxiety to commencing and continuing nursing students, and represents a significant academic challenge (Jordan, Davies, & Green, 1999; Gordon, Plenderleith, Hudson, Wirihana, & Craft, 2012; Craft et al., 2012). The general entry qualifications and a lack of background in the biological sciences and science generally are reported as contributing to poor academic performance in first year bioscience (Gresty & Cotton, 2003; Whyte, Madigan, & Drinkwater, 2011).. There is also an extensive vocabulary, describing concepts that are not easily acquired as part of everyday experience, which creates difficulties for first year students in many disciplines (Friedel & Treagust, 2005; Craft et al., 2012; Zhang, Lidbury, Richardson, Yates,, Gardiner, Bridgeman, Schulte, Roger, Mate, 2012).

The difficulties that many nursing students experience in their studies of biosciences are perpetuated by a practice environment in which senior staff nurses lack sufficient understanding of biomedical science and/or the confidence to communicate their knowledge in the context of their professional practice to students and junior staff (Campbell & Leathard, 2000; Clancy et al., 2000; Friedel & Treagust, 2005; McVicar, Clancy, & Mayes, 2010). Almost half (45%) of nurse educators felt that their science background was insufficient to understand all the bioscience required in modern nursing practice and 69% would like to have a better knowledge of bioscience (Friedel & Treagust, 2005). The problems that nursing students have with the biosciences can only be fully addressed when the scientific knowledge base of all nursing educators is improved so that the relevance of theory can be demonstrated in the clinical setting through its links to practice. This process can be started effectively using a combination of specialist science lecturers and nursing lecturers working collaboratively to provide basic science followed by demonstration of application to nursing practice (Larcombe & Dick, 2003), however an appropriate staffing mix and costs can present significant barriers to this approach.

TEACHING AND ASSESSMENT METHODS

Most first year nursing cohorts are quite large and diverse, including a substantial number of mature students without recent study experience (Cuthbertson, Lauder, Steele, Cleary, & Bradshaw, 2004; Whyte et al., 2011).The inexperienced and conservative learning style of nursing students is demonstrated by their preference for structured didactic lectures (Al-Modhefer & Roe, 2009), reliance on the prescribed text, and their reticence to seek and utilise additional print or electronic resources (Davies et al., 2000). A lack of confidence can make them resistant and even hostile towards an overtly interactive approach (Al-Modherfer & Roe, 2009). This learning style does not fit well with the development of critical thinking skills, reflective practice or maintenance of a current knowledge base. There is clearly a need to encourage a more active approach to learning in nursing students that can be sustained throughout their professional career. This requires a balance between structured teaching of concepts to direct and reassure the inexperienced learner with activities to encourage more self-motivated and inquisitive independent learning.

A traditional lecture format identifies key facts and concepts to guide further private study, and ensures that all students have been given the same information, but it does assign the student to a more passive role. Audience response systems have been used effectively with first year nursing students to promote active learning in lectures (Efstathiou & Bailey, 2012). The integration of practical problems can also present adult learners with the motivation to learn, leading to the development of more confident practitioners with a culture of continuing professional development (Smith and Coleman 2008). This approach, however, can also lead to frustration and resentment if both teachers and students are not thoroughly prepared and committed (Smith & Coleman, 2008).

Blended learning and e-Learning approaches have been used for teaching of bioscience to nursing students with the same advantages and disadvantages found in other disciplines (Kenny, 2002; Gresty & Cotton, 2003; Green et al., 2006). Although the flexibility and opportunities for active

learning in the online environment were appreciated by nursing students, it presents a significant technological challenge to students with poor computer skills (Kenny, 2002).

DEVELOPING A BIOSCIENCE COURSE FOR NURSES

The Bachelor of Nursing degree at the University of Newcastle is offered at three campuses: the main campus at Callaghan, the central coast campus at Ourimbah, and the Port Macquarie campus. The first year enrolments for this degree usually number between 600-700 students. Prior to the development of the course reported here, Bachelor of Nursing students took a general first year bioscience course along with students of Physical Education, Medical Radiation Science, Oral Health and Occupational Therapy. As it was a service course for a number of different programmes, it did not contain specific examples that demonstrated application of scientific principles to the nursing context. Nursing students had the highest failure rate of all the cohorts taking this course, and expressed low satisfaction with the course, in particular with the volume of factual content and a perceived lack of relevance to nursing. A new course was therefore specifically targeted to students of nursing and midwifery, and attempted to address the specific difficulties these students had encountered with the previous course. The course was structured around the Australian National Health Priority Areas (NHPAs), with both lectures and tutorials using clinical examples and case studies relevant to nursing students.

WEEK-BY-WEEK FORMAT

The Blackboard site for the course was structured in a simplified way, so that all course activities for a particular week were to be found in a single folder. Learning objectives, lecture notes, tutorial questions, tests and quizzes were all found a single folder. The intent of this simplification was to focus the attention of the students on the module for each week, and to minimise the chances of any student missing out on a required activity or a resource.

LECTURES

The level of detailed information delivered in lectures was reduced in order to focus on key concepts which could then be applied to clinical scenarios. The clinical application of these concepts was emphasised during the lectures, in order to lay the ground for students to make use of them to solve case-based problems during the tutorials. The requirement for a large scientific vocabulary was reduced in recognition of the fact that many of these students had little or no prior formal education in any of the sciences, and therefore very little scientific vocabulary on entry. The vocabulary students were required to learn and understand was that likely to be used and heard in a medical and healthcare context rather than a purely science and research context.

Lecture material was presented in the context of Australia's National Health Priority Areas (NHPAs) [http://www.aihw.gov.au/national-health-priority-areas/] where appropriate. For example, cell structure and function were presented within the "Control That Cell" module aligned with the NHPA *Cancer Control*, and digestion and metabolism were presented within the "You Are What You Eat" module aligned with the NHPA *Obesity.*

Traditional lectures are essentially a one-way communication. Although they are encouraged to actively participate, most first year students in large class groups are reluctant to ask or answer questions in lectures. To increase student engagement, reflection and communication, some lecturers used a variant on the 'clicker' style of student interaction tool during lectures. Short survey questions were integrated into lectures using the VotApedia audience response system [http://www.urvoting.com] to gauge student understanding of lecture content and to engage the students in use of the language and discussion of the material just covered. The emphasis was not on correct answers, but discussing why an answer was correct and why an alternative was incorrect or 'less' correct.

TUTORIALS

The reduced volume of material delivered in lectures was replaced by an increased focus on teaching students to apply the concepts taught to solving novel problems. Equal time was devoted to lectures and tutorials, with the rationale of providing a clear structured presentation of material to reassure inexperienced learners (during lectures) and the opportunity to develop active learning and critical thinking skills (during tutorials).

During tutorials, students were guided through a series of clinical scenarios which required them to apply the knowledge provided in the previous lecture in order to solve the problems. These sessions called for a high level of interactivity between teacher and students and were therefore initially held as small group tutorials. This integration of scientific concepts with clinical scenarios required experienced teaching staff with a broad skill set in basic and applied bioscience. It proved difficult to find sufficient numbers of staff with the capacity to successfully teach this application and problem solving in a small group tutorial setting during the first iteration of the course in 2011. Detailed tutors guides were produced and distributed to all tutors, in order to ensure consistency of approach and coverage of concepts, but in spite of this, student feedback suggested that there were inconsistencies between tutorial groups regarding the degree of importance placed on applying the lecture material to the clinical problems. Some students felt that their tutors were avoiding discussion on the clinical applications of the material, and others reported that tutors were departing completely from the clinical problems and presenting more lecture material Therefore, the tutorial was changed to a large-group activity (named a lectorial) led by an experienced teacher, during the second iteration of the course in 2012. The rationale for this decision was to provide a consistency of approach to ensure that all students were being taught the value of learning to apply information, rather than the value of learning the correct answer to a particular question.

REGULAR ONLINE TESTING

Short online multiple choice assessments were delivered on a weekly basis via the Blackboard site. Each test was made available to students at the end of the week and contained questions based on that week's work only. Students were also given access to additional practice questions to test themselves. Feedback and correct answers were provided for all test questions. The highest eight tests scores (out of a total of 11 tests) were taken to provide a proportion (40%) of the final course mark. The main intent of this regular testing was to encourage students to maintain regular and consistent study habits, and to reduce anxiety for the final exam, by providing regular exposure to questions of the same type that would appear in the final exam.

ASSESSMENT

The course was assessed by means of a series of online tests (40% of final mark) and a formal paper-based examination at the end of semester (60% of final mark). Passing the final exam was a requirement for passing the course. All assessment items were multiple choice questions that were written specifically for this course approximately half of the questions were constructed specifically to test higher order learning, and required application of concepts to clinical problems, whilst the other half required recall of concepts taught (see examples below).

Recall Questions

What kind of solution would a cell have to be placed into in order for water to move into the cell?
A. hypotonic solution
B. hypertonic solution
C. isotonic solution
D. tonic solution

Which valve prevents backward flow of blood into the left atrium ?
A. Aortic valve
B. Semilunar valve
C. Left atrioventricular valve
D. Pulmonary valve

Applied Questions

Sometimes, patients who have suffered severe blood loss are given a carbohydrate known as dextran intravenously. Dextran cannot get out of blood vessels. How do you think this will help the patient?
A. The dextran will increase the osmotic "pull" (osmotic pressure) within the blood vessels, holding more water in the blood vessels, and helping to maintain the circulating volume.
B. The dextran will increase the solute concentration within the blood, allowing more water to leave the blood, and hydrate the cells.
C. The dextran will remain in the blood until it reaches the areas of most need, and will then be able to supply energy to the cells that need it most.
D. The dextran will trigger the division of red blood cells within blood vessels, allowing quicker recovery of the circulating volume.

A patient has a tumour in her hypothalamus which causes insufficient Anti-Diuretic Hormone secretion. When her blood pressure is taken, which of the following readings would you therefore expect?
A. 95/65 mm Hg
B. 115/80 mm Hg
C. 120/65 mm Hg
D. 165/100 mm Hg

STUDENT OUTCOMES

ATTITUDE AND CONFIDENCE

As part of the final online formative assessment task, students were asked a number of questions regarding their attitude to bioscience, its relevance to nursing and their confidence in passing the course (Table 1). A large proportion of the class responded to the questions in 2011 (n=387, 65.9%) and 2012 (n=520, 71.0%), and most agreed or strongly agreed that bioscience was relevant to their practice. Most students found the course interesting and expressed a desire to know more about human biology (Table 1), but were only moderately confident about how well they did in the course. There was little correlation between student confidence and final grade in the course (r=0.28).

Table 1: First year nursing students' attitude to bioscience, its relevance to nursing and their confidence in passing HUBS1406 Human Bioscience for Nursing and Midwifery in 2011 (n=397) and 2012 (n=520). Students completed the survey via the course Blackboard site during the last week of semester.

Question	2011 (mean ± S.D.)	2012 (mean ± S.D.)
Understanding body function is important to a nurses' or a midwife's ability to practice well	4.70 ± 0.53	4.72± 0.50
The material covered in this course was interesting	4.22 ± 0.70	4.25 ± 0.67
Studying human biology has given me a desire to know more	4.26 ± 0.72	4.22 ± 0.74
I feel I did well in this Human Bioscience course	3.30 ± 0.90	3.41 ± 0.90

Rating, 1= strongly disagree, 2= disagree, 3=neutral, 4=agree, 5=strongly agree

EVALUATION OF COURSE

Students were surveyed by the University of Newcastle's Planning, Quality and Reporting Unit over the final two weeks of semester and the examination period in 2011 and 2012. A Likert scale (1= strongly disagree, 2= disagree, 3=neutral, 4=agree, 5=strongly agree) was used to record student responses to the following survey questions:

- *Motivation:* The activities of this course motivated me to learn.
- *Structure:* The various components of this course were linked in ways that supported my learning.
- *Assessment:* The assessment items were clearly related to the learning objectives.
- *Relevance:* I am able to apply my learning from this course to my wider goals.
- *Outcomes:* My knowledge and skills have developed as result of studying this course.
- *Support:* The teaching staff were available to help me with my learning.
- *Satisfaction:* Overall, I am satisfied with the quality of this course.

Several aspects of the course were rated significantly higher in 2012 compared to 2011, including support ($p<0.001$), structure ($p=0.002$), outcomes ($p=0.003$), assessment ($p<0.001$), relevance ($p=0.008$) and overall satisfaction ($p<0.001$) (Figure 1). There was no significant change in student motivation based on the learning activities provided in the course. There are many factors that may have contributed to the increased student feedback scores for HUBS1406 in 2012; there was a major change to the structure and content of the tutorial/lectorial sessions, and the demographics or background knowledge of the two cohorts may differ. Importantly though, the increased staff-student ratio that resulted from the introduction of the lectorial did not have a negative impact on the students perception of the amount of support that they received from staff.

Student feedback on the course in 2011 contained a number of negative comments about the small group tutorials, especially the perceived inequalities between tutor ability and engagement with

students. Student comments in 2012 produced a roughly equal number of negative comments about the large group (lectorial) approach, and in this case, comments were largely centred around the intimidating size of the group and the perceived difficulty in contributing to the discussion e.g.

"Still effective but large group was indimidating (sic) when wanting to ask question"

The 2012 student cohort experienced the whole group lectorial approach in this first semester course, and then went on to experience the small group tutorial approach in their second semester bioscience course, and were therefore in a position to directly compare the two approaches by the end of their first year. By that time, the feedback was overwhelmingly in favour of the large lectorial approach e.g.

"The mass tutorial group in the first semester was better for learning, as we all got taught the same stuff"

"Massive tutorial and lecture is much better than an individual stream tutorial."

"I think the mass tutorial was much better, I gained a lot more from them."

"Second semester should be modelled off how first semester was taught with the mass tutorial and the one teacher. This ensured continuity of the standard of teaching, as well as allowed information to be processed easier."

"I strongly agree on bringing back mass tutorials as I was more motivated to attend them as they were more enjoyable and more beneficial to myself and also others as we were getting all the same information as every other student and also that no one appeared to be disadvantaged in any way as we all recieved (sic) the same information and answers were explained in more depth"

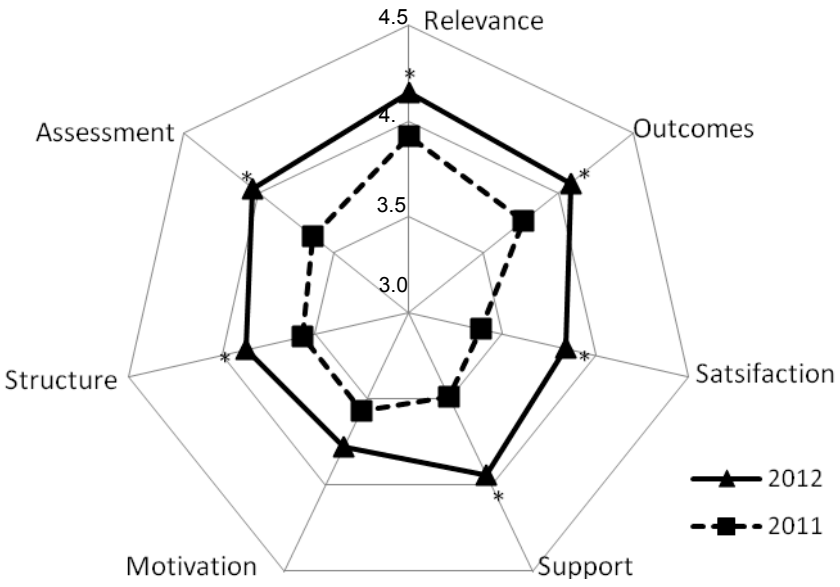

Figure 1: Student feedback on course scores (mean) for HUBS1406 Human Bioscience for Nursing and Midwifery in 2011 (n=215) and 2012 (n=236).

Rating, 1= strongly disagree, 2= disagree, 3=neutral, 4=agree, 5=strongly agree.

Motivation: The activities of this course motivated me to learn; **Structure**: The various components of this course were linked in ways that supported my learning; **Assessment**: The assessment items were clearly related to the learning objectives; **Relevance**: I am able to apply my learning from this course to my wider goals; **Outcomes**: My knowledge and skills have developed as result of studying this course; **Satisfaction**: Overall, I am satisfied with the quality of this course; **Support**: The teaching staff were available to help me with my learning.

* p<0.01, t-test.

GRADES

The mean mark achieved by students in 2012 (68.0, SD=12.9) was significantly higher ($p<0.001$, t-test) than the previous year (59.6, SD=12.4). This is reflected in the distribution of grades in Figure 2. The failure rate of nursing students in first year bioscience was 30-40% in 2008-2010. A similar fail rate (34%) occurred during the first year of the course designed specifically for nurses, but dropped to 13.6% in 2012 (Figure 2).

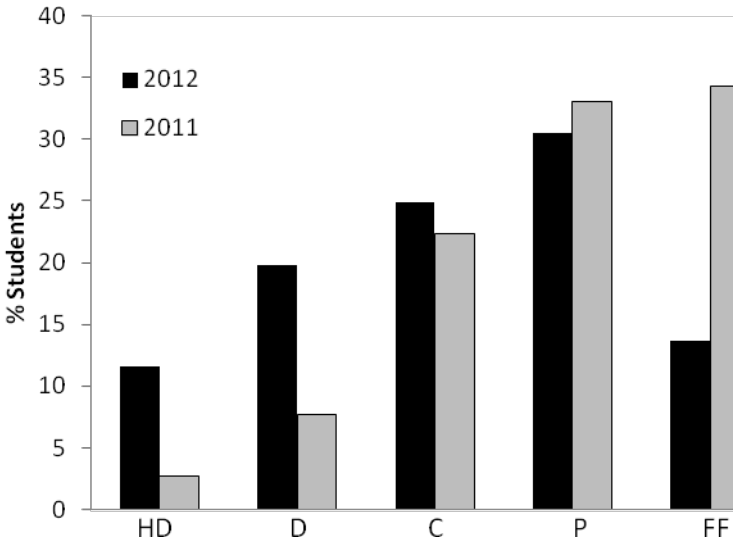

Figure 2: The distribution of grades achieved by students in HUBS1406 Human Bioscience for Nursing and Midwifery in 2011 (n=587) and 2012 (n=732).
HD, 85-100%; D, 75-84%; C, 65-74%; P, 50-64%; FF, <50%.

CONCLUSION

A course in bioscience delivered to students of health professions such as nursing and midwifery needs, first and foremost, to capture the interest and develop motivation for learning in students who may not have shown a particular interest in science or chosen to study science. Being able to achieve this relies heavily on making the relevance of the scientific knowledge to clinical practice very clear at every stage of the course. To convey to students not just the relevance of science to clinical practice, but the importance of science as an underpinning of good practice, requires that the course teaches students not just the course content, but how to use that content. While the ability to apply knowledge and problem solve is commonly listed as a graduate attribute, in practice, most teaching time is given over to conveying the required knowledge for the course, with very little being given over to teaching students how to apply their knowledge. This course has devoted equal time to each of these important activities, and divided the assessment equally between assessing these two attributes. Students appeared to recognise the value of the lectorial activity in developing their comprehension and application skills, and this seems to be supported by the improvement in student feedback scores and also in course results. Interestingly, in spite of the withdrawal of small group teaching in favour of a large group lectorial, students felt that they were better supported than in previous iterations of the course. The use of an audience response system that allows students to ask questions via SMS has been introduced to lectorials during 2013, to further encourage student interaction in the large group setting. So far, the informal feedback regarding this system has been very positive, and the increased interaction with students who might otherwise not contribute to the discussion has allowed teaching staff to identify and address misconceptions during the lectorial sessions.

The change of focus from a bioscience content-driven course to a context-driven course seems to have produced positive results in terms of student academic success and satisfaction. The findings of this study suggest that it is worth reducing content in order to make time and space in the curriculum to focus on the meaning and application of bioscience in a clinical context. Further, teaching style may be a more important determinant of student satisfaction and performance than class size. This has significant implications for large first year science courses in health professional degrees.

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