Real world problems in developing a critical thinking approach to learning in Pharmacology

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Introduction

In Australia, there are 27000 products listed on the Australian Register of Therapeutic Medicines with 8700 ingredients that comprise these goods (Therapeutic Goods Administration, 2009). Pharmacists are expected to be familiar with approximately 520 commonly used drugs (Australian Pharmaceutical Formulary and Handbook, 2009). This includes an understanding of the mechanisms of action, pharmacokinetics, use in pregnancy and potential side effects for each product and an ability to comprehend the research and commercial literature which provides sources of drug information.

Undergraduate courses that teach the pharmacology (biological action of drugs) of over the counter (OTC) and practitioner prescribed medications require significant recall of facts and information and it is often easy to neglect key graduate skills that require the use of higher order thinking skills and critical evaluation of both data and text. Obviously it is not possible to learn all the information required of each individual product registered with the Therapeutics Goods Administration, hence educational courses should provide students with enough understanding of the fundamental action of drug classes and the ability to process the information that will assist the students capability to continue learning as they become experienced health practitioners (Fraser and Greenhalgh, 2001).

Theories of constructivism (that learners formulate new understandings by building on their own prior ideas) from cognitive psychology also indicate that learning improves when information is surrounded within meaningful contexts (Williams, 2001). Long lists of drug names can inundate students when they are trying to learn the underlying action of drugs. Furthermore, student engagement can decline when the relevance of the learning material is not immediately evident to students. Hence they should be taught in drug classes based on how they work in biological systems. For example, in the treatment of depression, antidepressants such as fluoxetine (Prozac®) are taught under the class name of selective serotonin reuptake inhibitors (SSRIs). A positive relationship exists between student interest and student learning (Kweik, et al., 2007), therefore it is essential that lecturers tap into the students curiosity. Topics and approaches to arouse student interest can help motivate students to learn and increase achievement (Sandoval, 1995). This is recognised in problem based learning where drug therapies are usually taught in the context of disease pathologies and incorporated into clinical case studies.

Teaching strategies that encourage the practical application of theoretical principles should be used (Ax and Kincade, 2001). Courses need to incorporate flexible learning and teaching strategies to educate for capacity. To be engaged students must be provided with problems that are challenging and developmental. The course outcomes must have unambiguous goals and students need protected time for reflection and independent study. Mentoring and peer review are essential for students to develop a new array of skills such as applying clinical reasoning strategies when communicating with clients.

More importantly in a rapidly changing world, students must be able to adjust their thinking as new products are released into the market, they need to comprehend new information and continue to improve their expertise in their chosen profession. With a rapidly changing knowledge base in the biological sciences, graduates need an understanding of core concepts as well as an ability to accommodate continual change (Watters and Watters, 2007). Hence, having a substantial theoretical foundation will provide the support to deal with clinical updates and postgraduate study (Banning, 2003). To thrive in their chosen careers, students need to develop skills that will play a role in post university life including complex problem solving, flexibility and an ability to develop original ideas. At Griffith University we implement teaching and learning programs with the expectation that graduates when they leave will be able to communicate effectively, be information literate, able to solve problems and make critical evaluations, to work autonomously and in teams, be creative and innovative, behave ethically and be responsible and effective citizens (Griffith Graduate Statement, 2009).

The purpose of this study was to explore a framework for effective teaching and learning that can be used to teach the principles of applied pharmacology and therapeutics in an undergraduate pharmacy program through a suite of innovative and distinctive activities to promote learning and to engage students.

Background

Most of the Bachleor of Pharmaceutical Science students in this study came from the top 20% (OP1-6, Queensland Studies Authority, 2009) of secondary school leavers in Queensland. Once they complete their undergraduate degree, they then enter a full fee paying Masters of Pharmacy program in their pathway to qualification as a professional pharmacist. Although these students are generally high performing and motivated, it became apparent through assessment instruments that too much emphasis was placed on knowledge of facts and information. Pharmacology is an interdisciplinary science that requires central knowledge of basic sciences including biochemistry, anatomy and physiology and clinical medicines (Watanabe et al., 2004).

Previously students have achieved their best results on factual-recall-type questions as compared to higher order application or analysis-type questions and hence have generally been resistant to engaging in tasks outside the scope of what current assessment items cover. Information delivered in a mass lecture format accompanied by multiple choice examinations rewards a culture of learning by memorisation. Instructive approaches based on mass lecture and workshop experiences have remained fundamentally the same for many years despite an advance made in other disciplines in curricula such as problem based learning (Gijselaers, 1996).

As students will be communicating with clients or health professionals in a qualified capacity regarding drug therapies, it is imperative to engage this cohort of students to empahasize important aspects in the use of medications including adverse drug reactions, drug interactions or use in children or pregnant women.

Problem based tasks have been implemented to stimulate higher order mental activity in students undertaking science laboratory practical classes (Cruichshank and Olander, 2002; Yeretich 2004). Over the past few years other forms of teaching methods have been reported for teaching pharmacology including problem based learning (Tisonova et al., 2005), Web based exercises (Tse et al., 2007; Tse and Lo, 2008) or competitions (Persky et al., 2007). In the field of pharmacology, there are still very limited resources available to teach these skills in the education of pharmacy students. Hence, resources need to be developed to teach relevant fundamental concepts associated with drug action.

A program grounded in educational theory was designed to cultivate critical analytical skills in Pharmaceutical Science students. This was intended to reduce the dependence on traditional teaching strategies that focus on memorising vast amounts of information without any insight into solving practical problems and moved toward developing teaching and evaluation strategies to engage the students and facilitate higher learning in the discipline of pharmacology.

Method

Tutorial problems were designed using materials from a variety of sources to extend student learning from recall and understanding to higher levels of thinking (including application, analysis, synthesis and evaluation of information (Lord and Baviskar, 2007). This has involved streamlining the different topics in the course into themes for further exploration as practical problems for the students to answer. Typically a tutorial class begins with an overview of relevant background with a focus on the relevant concepts. Students will then complete the assigned problems to emphasize the importance of underlying ideas. The tutorials have been designed to move away from didactic teaching to a facilitatory style where students are encouraged to articulate and theorise answers to questions using prior knowledge and experiences to interpret and solve problems (Banning, 2005).

A diverse range of source material such as newspapers, journal articles, extracts from the Australian Adverse Drug Reactions Bulletin and television programs are implemented to determine contemporary issues in pharmacology, therapeutics or general medicine as the study of science to societal problems is one way of engaging students (Ramaley and Haggett, 2005). Students are challenged to review the material and complete exercises that require significant understanding of pharmacological principles.

As part of these exercises, students are expected to ask questions to assist their own education. Through their participation in and receiving of valuable feedback from the tutor, students have been able develop higher order thinking skills. The resultant discussions are used to clarify student understanding as well as provide students time to reflect on their learning. As pharmacology is interdisciplinary it also allows students to explore what they have learnt previously in other fields such as anatomy, physiology, biochemistry and psychology. Quite often misconceptions are clarified and myths are displaced. Furthermore, working in groups exposes students to genuine, investigative and cooperative learning strategies. Students are also aware that tutorial assessment items will be based on problem solving ability.

An example

The following is an example of a problem developed for these courses;

Postie awarded $2.6m for botched injection; ABC News 4th February, 2005

"A Sydney man has been awarded $2.6 million in damages after the ambulance service failed to treat him properly for an allergic reaction. In October 1998 postal worker Stephen Paul Worley was delivering mail in the western Sydney suburb of Glendenning when he was stung by a bee on his neck. Despite suffering a severe allergic reaction, he managed to return to his work headquarters and an ambulance was called. But Mr Worley suffered a brain haemorrhage when the paramedics injected a dose of adrenaline into his vein, instead of into a muscle. In the Supreme Court today Justice Graham Barr awarded Mr Worley $2.6 million for damages and loss of earnings. The ambulance service has since changed its policy on how to administer adrenaline."

Students begin with a small exercise in comprehension (question 1). Then they work through some of the lower order questions searching for knowledge (questions 2, 4 and 9) and application (question 3).

The question supplied to the students were as follows:

1. In three (3) sentences or less describe the main points of this article.

2. What are the clinical uses of adrenaline?

3. Adrenaline is used to treat severe allergic reactions. Use a flow diagram to explain the mechanism of action.

4. What are the potential side effects associated with adrenaline use?

Then they work through some of the higher order questions which include analysis (questions 5 and 6), synthesis (question 10) and evaluation (questions 7 and 8).

5. Using a graph indicate how the plasma concentration of an equivalent dose of adrenaline would vary over time if given by an;

   a. intramuscular injection

   b. intravenous injection?

6. Account for the variation in blood plasma levels of adrenaline when given via intramuscular or intravenous injection.

7. When would an intravenous application be recommended for adrenaline?

8. How could adrenaline cause a brain haemorrhage?

9. Explain how you could reverse the effects of adrenaline.

10. Draw a schematic flow chart for your recommendations for ambulance staff to treat patients using adrenaline.

Students were given the problems well in advance and encouraged to answer each question on their own, find the relevant information and given time to reflect on their answers. In the tutorials (30 students) they formed groups of 3-4 to discuss their answers. A formal discussion of the whole group then proceeded to discuss their findings.

Data Collection

At the end of each semester, course evaluation surveys were obtained. A 7 point Likert scale was implemented as follows. 1 = Unacceptable; 2 = Very Poor; 3 = Poor; 4 = Average; 5 = Good; 6 = Very Good; E = Excellent.

Results

Students enrolled the pharmacology courses were in the third year of their undergraduate Bachelor of Pharmaceutical Science degree program at Griffith University. The vast majority of students in this study had entered university from the secondary high school system and were 19-21 years of age. Course evaluations following at the end of semester showed that students found the way problems were structured helped them to understand concepts in pharmacology and provided them with a range of intellectual challenges.

Over the three years that critical thinking activities were introduced into the curriculum, the tutorial questions consistently obtained a score >5.6 for effectiveness of the teaching methods and > 5.8 for effectiveness of the course in helping students to learn (see Table 1). Feedback from students for tutorial evaluations in semester 2, 2007 has been overwhelmingly positive with students finding the problems valuable in helping them understand (5.91) and providing a range of intellectual challenges (5.94, see figure 1, 42% response rate).

Talking regularly to students and tutors also provided valuable feedback in determining whether students find the tutorial tasks aid in their understanding of pharmacology. The tutorial questions are regularly reviewed and updated to maintain coverage of essential topics and encompass the latest changes or controversies that arise with regard to drugs in our society.

Table 1. Student evaluation of Pharmacology courses 2005-2007.

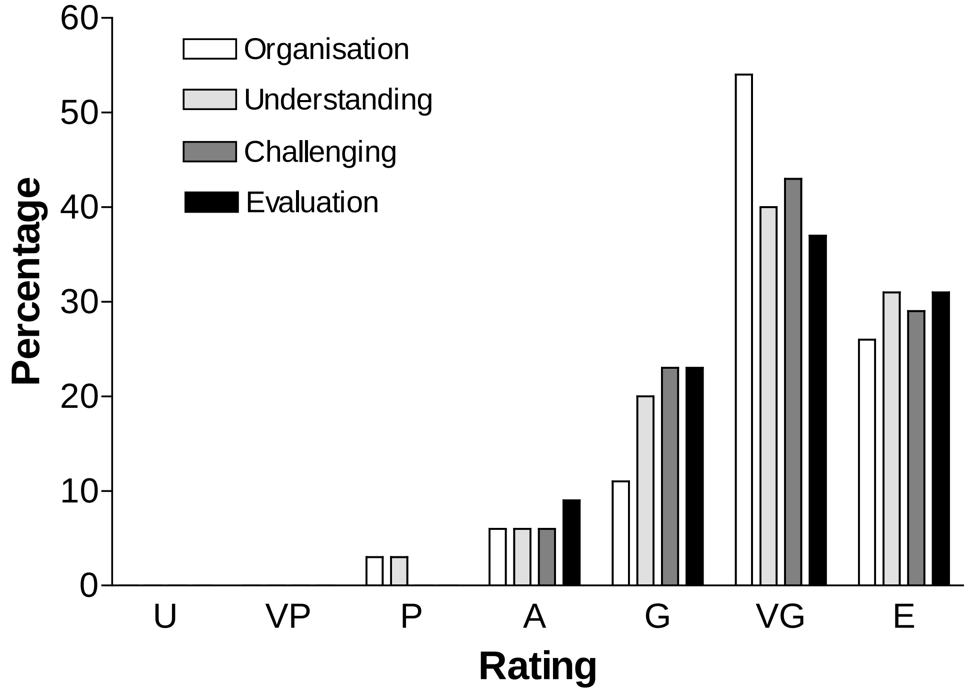
	SemI 2005 (n=41)	**SemII 2005 (n=26)**	**SemI 2006 (n=35)**	**SemII 2006 (n=39)**	**SemII 2007 (n=31)**
Q1	**6.1**	**6.38**	**5.60**	**6.13**	**6.14**
Q2	**6.2**	**6.54**	**5.80**	**6.0**	**6.2**

Q1 How effectively did the teaching methods used in this course work together to help you to learn?

Q2. Overall, how effective was this course in helping you learn?

(7) Excellent, (6) Very Good, (5) Good, (4) Average, (3) Poor, (2) very poor (1) unacceptable.

Figure 1. Student evaluation of tutorial questions in the Pharmacology semester II course 2007.



Organisation: How well organised were the tutorials/seminars?

Understanding: How effective was the way the problems were structured in helping you understand?

Challenging: How effective was the course in providing you with a range of intellectual challenges?

Evaluation: How effective was the course in helping you to develop an ability to evaluate knowledge?

Discussion

Pharmacy students have to be knowledgeable about the plethora of drugs available for clinical use in Australia. They are required to understand the mechanism of drug action and its consequences from an adverse drug reaction perspective and be able to manage changes in their work knowledge requirements once they have graduated from university and entered the workforce. A range of real world problems were developed to help cultivate an approach to problem solving using critical thinking processes that incorporate prior knowledge with amassed information from drug databases or research literature to resolve issues. Having had an opportunity to reflect on student performance, the approach outlined in the results section demonstrates that real world problems aid students in acquiring a deep understanding of the subject material.

Limited resources are currently available to teach pharmacology, however published approaches include problem based learning (Tisonova et al., 2005), competitions (Persky et al., 2007), songs (MacDonald and Saarti, 2005) prescription pad exercises (Bata-Jones, 2005) or web based activities (Tse et al., 2007; Tse and Lo, 2008). In this paper the use of real world problems reported through a variety of medium have been incorporated to develop critical thinking skills. Other researchers have stated that a variety of process orientated learning methods should be used to educate for capability, promote reflection and critical thinking skills and to improve the student experience of learning (Davies and Hughes, 1995; Shell, 2001). In addition to instructional learning, non-linear learning methods should be included such as role play, small group discussion, problem solving exercises and patient simulation (Wong and Chung, 2002). Students reported the problems to be challenging which indicates engagement with the material.

The use of research literature in teaching pharmacology introduced students to significant clinical trials and evidence based practice and provided insight into the processes that change procedures in prescribing drugs in a clinical setting. With respect to the origin of information, new innovative ideas or changes in clinical approaches students need to appreciate the significance of appraisal and utilisation of research evidence to support practice (Carnwell, 2001; White and Taylor, 2002).

In conclusion, the implementation of real world problems in these classes engaged students to apply their knowledge and critical thinking skills to learn the discipline of pharmacology.

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