Periodic review sessions contribute to student learning across the disciplines in Pharmacology

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Abstract: Background: The teaching of the discipline of pharmacology is in constant flux. In order to meet the challenges of teaching pharmacology effectively we investigated a new teaching and learning strategy. Aim: Our aim was to investigate whether structured periodic review sessions (RS) could improve teaching and learning for students in a multidisciplinary undergraduate pharmacology module. Methods: Following each lecture students were asked to identify topics of difficulty in pharmacology using the one minute paper classroom assessment technique (CAT). Three review sessions were then introduced based on the problematic issues identified by students. They completed a pre- and post-review session multiple choice question (MCQ) examination to gauge improvements in their learning. Feedback was obtained from students at the end of the module regarding the acceptability, advantages and limitations of the CATs and the review sessions. Results: There was active participation by students in all thirteen CATs (71.15% ± 1.2%), three review sessions (78.3% ± 1.6%) and the end of module (EOM) questionnaire (81%). A significant increase in student learning across all disciplines was observed in all three review sesegr M)

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evaluation methods whose main aims are to permit assessment of student understanding and learning and to allow for timely feedback about the effectiveness of particular teaching techniques. Approximately fifty different CATs have been described to-date (Angelo, 1991a,b; 1998; Angelo & Cross, 1993; Byon, 2005; Rouseff-Baker & Holm, 2004) with limited qualitative and quantitative research assessing their value in improving student learning (Cottell & Harwood, 1998; Simpson-Beck, 2011). Some CATs access student prior knowledge, recall and understanding (minute paper, muddiest point, background knowledge probe and memory matrix), while others assess student's skill set in analysis and critical thinking (pro-and-con grid, categorizing grid, defining features matrix and content, form and function outlines). Furthermore,

normally takes longer than one minute so students can process the lecture material and provide a response (Stead, 2012)). CATs are an invaluable learning tool not only for students but for the teacher as well. The advantages and disadvantages of the one minute paper have recently been reviewed (Stead, 2012), (iii) *Analysis*: CATs from all participating students were carefully read to ascertain the areas of student difficulties as well as ease in the preceding lecture. CATs were pooled from the first four lectures for RS1, the next four lectures for RS2 and the remaining five lectures for RS3. Topics of difficulty were entered into an excel sheet and formed the basis for each of the three subsequent RS. Each RS was based on six pharmacological topics most frequently identified as difficult by students.

Description of the three Review Sessions

RS1 and RS2 were conducted after a block of four lectures each covering inflammation and antimicrobial chemotherapy respectively. RS3 occurred following the remaining five lectures in the module covering cancer chemotherapy.

Design and conducting of Review Sessions including MCQ examinations

(i) Review topics: Six topics of difficulty identified most frequently by students formed the basis of the material to be re-addressed in the RS as well as the pre- and post-review MCQ questions. A single MCQ topic was assigned to each of the six problematic areas with five different questions of format T/F/D (true/false/don't know) associated with the topic. *(ii) Format of the RS*: Students completed the MCQ questions (6 topics x 5 T/F/D MCQ questions =30 questions in total) in the first fifteen minutes. The next thirty minutes was devoted to revisiting the six problematic areas identified by students in their CATs. The review time was used to reinforce the important and fundamental aspects of the six different pharmacological topics using an interactive teacher/student powerpoint presentation. The remaining fifteen minutes was allocated to the students re-sitting the same MCQ questions presented in the pre-review MCQ. Both pre- and post-review MCQs were printed on different colored paper and stapled together to allow analysis of student learning from individual students, while maintaining student anonymity. All MCQs were conducted anonymously except through identification of student discipline.

Strategies to design the Review Sessions and MCQs

Key challenges in designing and conducting the RS (as well as teaching the module in general) was to keep to the forefront the knowledge that the student group was diverse and from different disciplines. Thus, different criteria were adhered to in designing the MCQ examination questions (which did not differ in the pre- and post-review MCQ examination) as well as how the material identified by students was to be re-visited during the RS. Four different strategies were employed: (i) relevant; questions were designed and material was reviewed at an appropriate level to reflect the backgrounds, needs and diversity of students. All material was closely aligned with learning outcomes of the module; (ii) realistic; the level of pharmacology that the students required at this point in their training was taken into account (iii) engaging; both MCQ questions and material reviewed incorporated a mix of straight forward knowledge based enquiry as well as more challenging aspects of pharmacology (Bloom's Taxonomy, 1956) and (iv) instructional;

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Results

CAT participation and analysis

All students present actively participated in the CATs following each lecture. Mean total class participation for all thirteen CATs was 71.15% ± 1.2%. Interestingly there was no statistically significant difference in student attendance and participation (there was 100% correlation) in all thirteen CATs despite frequent EOM examinations in other subjects towards the end of the teaching period (data not shown).

The most frequent

Table 1

Student CAT analysis

Lecture number	Analysis of student CATs	Six main areas of student difficulty
1-4	Pro- and anti-inflammatory pathways	(i) AA, (ii) PPAR, (iii) HPA
	Cox-2 specific inhibitors	(iv) Mechanisms of drug specificity
	Paracetamol	(v) Mechanism of drug poisoning and treatment
	Glucocorticoids	(vi) Mechanisms of action
5-8	Antibiotics	(i) -lactam cell wall synthesis inhibitors
	Drug inducers and inhibitors	(ii) Cytochrome P450 family
	Folate as a pharmacological tool	(iii) Folate synthesis, metabolism and utilisation
	Anti-virals	(iv) Mechanism of action of acyclovir
	Antifungals	(v) Mechanism of action of flucytosine
	Anti-malarials	(vi) Mechanisms of anti-malarial drug resistance
9-12	Cancer genetics	(i) Prot-oncogenes versus oncogenes
	Anticancer drugs	Mechanisms of action of (ii) topoisomerase inhibitors, (iii) aromatase inhibitors, (iv) EDGF inhibitors
	Cancer proliferation and apoptosis	(v) Cell cycle control
	Drug resistance	(vi) Cancer multi-drug resistan

All CATs were a one minute paper completed by students at the end of each lecture. Six main areas of student difficulties were identified from lectures 1-4 for RS 1, lectures 5-8 for RS2 and lectures 9-13 for RS 3. AA; arachidonic acid, PPAR; peroxisome proliferator-activated receptors, HPA; hypothalamic pituitary axis.

individual drug. Thus, we employed a teaching technique using pr 0 0 50.2 Feyithcoπrued

management of specific diseases (medical students) and focusing on core pharmacological aspects (Erasmus students). The structured RS permitted more discipline driven teaching of pharmacology that was not always possible in the lectures. This was mainly driven by the fact that more time could be devoted to individual discipline related topics. Topics requiring further revision or clarification were clearly outlined by students' CATs and so could be specifically

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discipline. Moreover,

Erasmus student group demonstrated a significant increase in their understanding of drug pharmacodyamics across a range of drug classes in all three RS (data not shown). This was not evident in the Erasmus group as they performed particularly well in this area of pharmacology in both their pre- and post-review MCQ examinations. This may be related to the fact that 80% of the visiting Erasmus student group was undertaking a pharmacy degree in their home country whereupon they may have previously undertaken a pharmacology module covering the pharmacodymanics of commonly used drugs. Lastly, of note it was the area of drug resistance in particular that proved most difficult for all student groups as evident from the lower mean correct MCQ answers in both the pre- and post-review MCQ (Figure 2). This was somewhat surprising as students are taught that in general drug resistance is related to drug pharmacodymanics. Once knowledge and understanding of a drug's mechanism of action is obtained, then by inference, so too is the mode of resistance associated with that drug. Overall, however, it was encouraging to see that there was a significant improvement in student learning in terms of core as well as applied pharmacological knowledge in all three RS (Figure 3).

Similar to the RS, the MCQ examinations provided a teaching and learning opportunity. In terms of teaching, there was an opportunity to ask students multiple targeted questions which is not possible in a traditional lecture. It also allowed for timely assessment of students' knowledge and understanding. From the student perspective the MCQs helped focus students' attention throughout the RS. They helped connect topics together which were specifically outlined by the students themselves and not the teacher. The MCQs provided opportunities for student self-assessment, a chance for the students to practice dealing with typical MCQs prior to the EOM MCQ examination and demonstrated to them the level of core and applied knowledge that was required in different pharmacological areas. Overall the MCQs enhanced student engagement and specifically guided student test taking logic.

Questionnaire

To investigate the effects of the various strategies used in this study student feedback was obtained using a written questionnaire covering various aspects of teaching, learning and assessment methods. Active participation was evident in all student disciplin

as 94% of respondents indicated that the RS were closely aligned with topics students found difficult while 92% indicated that the MCQ questions were at an appropriate level (statement 5, Table 4). Ninety percent of students welcomed active participation in their own assessment as a means to improving their overall leaning and understanding (statement 6, Table 4). Finally the majority of respondents (99%) agreed that the RS enhanced their learning outlining the positive

issues which are more difficult to tackle and could continue to have considerable controlling or restrict

One of the important findings of this study is that, despite the differences in student disciplines and backgrounds they succeeded in using the RS to their advantage and improving their understanding and knowledge of both core and applied pharmacological concepts. Student performances significantly improved following participation in the RS as evident from analysis of pre- versus post-review MCQ examination results for each individuals student. This

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future studies might provide more nuanced understandings of its effectiveness beyond the discipline of pharmacology.

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