Australasian Journal of Peer Learning (2008) 1: 26-39

Student-Creation of eCases for Clinical Reasoning in Pharmacy

Mary Au Yeung[1], Paul Lam[2] and Carmel McNaught[2]
[1]*School of Pharmacy*
[2]*Centre for Learning Enhancement And Research (CLEAR)*
The Chinese University of Hong Kong

ABSTRACT

Case-based activities are widely proclaimed to enable better learning through allowing students to practice application of concepts in real-life situations. This paper reports an investigation into the learning benefits derived from engaging students in the development of Pharmacy eCases. This is a small scale pilot study. Two student-developers were actively involved in a year-long project where they converted authentic patient cases encountered from a hospital-based clinical clerkship into pedagogically sound eCases. The purpose of this phase of study is to gather experience to inform an expanded phase of eCase development. Several benefits were found. First, the student-developers noted learning benefits for both their knowledge and skills. Second, the peer students perceived learning benefits on knowledge improvement and agreed that the cases developed are relevant for pharmacy practice. Finally, the teacher gained constructive inputs from students on how to enhance the development of eCases in the expanded phase.

STUDENT-CREATED WEB-BASED TEACHING MATERIALS

Students can learn through taking the role of a teacher. These teaching responsibilities can vary from preparation of teaching materials to giving a seminar in class. The tasks include peer-tutoring, peer-mentoring, peer-modeling, peer-monitoring, and peer-assessment (Topping and Ehly, 2001). This paper focuses on the activity in which students create learning materials for their peer students. The student-created learning materials in this study are eCases: web-based resources which involve problem-solving tasks based on authentic cases.

We base our own work on a broadly learner-centred paradigm of teaching and learning (e.g. Laurillard, 2002; Biggs, 2003) where students are actively involved in the manipulation and construction of knowledge representations. Peer-teaching activities conform to a social constructivist point of view (Vygotsky, 1978; Collins, Brown and Newman, 1989) as students are co-constructing knowledge through communicating their own interpretations of concepts. In fact, both the students taking up the roles of the teachers (student-teachers) and the students (peer students) can benefit.

McLuckie and Topping (2004) suggested that student-teachers learn as they actively construct knowledge through reflecting upon, organising and transferring what they have learnt into teaching instructions. Goldschmid and Goldschmid

Published by the University of Wollongong
ISSN 1835-856X

(1976) suggested that the benefits increase with the time students spend with their peers in collaborative learning. Students are more aware of the learning difficulties of their peers and are thus able to deliver more appropriate instructions. Simsek and Hooper (1992) suggested that student-teachers are able to come up with examples and explanations that are related to the contexts shared by peer students which may not be part of the teachers' lives.

Research findings tend to support that students can benefit through contributing to the development of course materials. Cochrane (2005) reported a study of the reusability of online learning objects in the discipline of audio engineering. The study began with a needs analysis where tutors (postgraduate students) listed their expectations for interactive learning objects. These expectations served as the basis for later evaluations of the learning objects.

Eagleton (2006) studied the learning benefits of Grade 7 and 8 students when they were asked to create their school website. He noted students' enthusiasm for the authenticity of the task, their ability to use multiple forms of symbolic representations, their understanding of complex information, the increased use of language skills in collaborative negotiations, and their abilities in trouble-shooting strategies and group working skills were enhanced. Student-designed web development thus appears to be a valuable activity for the students. The tasks often invite students to actively engage in the course curriculum or professional area of interest so that they can, to a certain extent, decide on what and how they should learn (Short and Burke, 1991).

Students can develop highly enhanced learning resources for their peers. McNaught, Lam and Cheng (2007) reported four cases that involved university students at the predevelopment stage of eLearning projects. They concluded that the student designs improved the quality of the eLearning strategies and content. The student-developers contributed to the development by supplying information on:

1. students' views on eLearning – students' comments on their expectations of the role that the web can play in assisting learning can be illuminating;
2. the difficulties met in learning concepts in the discipline – understanding students' existing conceptions (and misconceptions) can allow materials and activities to be developed which challenge students to address the discrepancies between their own views and the current consensus views of the discipline; and
3. ideas for eLearning strategies and design – many students are sophisticated web users and their comments on actual designs can assist in the identification of strengths and weaknesses in the overall website design, as well as the design of specific activities and resources.

Involving students in the development of courseware using web technologies can have other advantages too. Apart from the computer skills they can acquire, the task also fosters collaborative and cooperative learning between and among students. All these are required skills for future work situations (Roblyer, 2002; Jonassen, Peck and Wilson, 1999). Agnew, Kellerman and Meyer (1996) also suggested that web-based multimedia projects often involve a wider spectrum of activities and provide a richer range of experiences than print-based projects.

ECASES IN PHARMACY

The use of the case-based approach to assist teaching of pharmacy is an accepted strategy (Swinghammer, 2002; Kidd et al., 2002). Learning theoretical knowledge alone is not sufficient. It is the ability to apply the theoretical knowledge that enables students to function professionally in the discipline after graduation. One problem faced by undergraduate pharmacy students in the University of this study (The Chinese University of Hong Kong, CUHK) is the limited opportunity to practice knowledge application in real-life situations during early years of study. The Bachelor of Pharmacy is a three-year program in our university. Although students start to learn about drug use in disease management in their second year of study, the opportunity of working with actual patients is arranged in the last term of their third year study. Thus, the provision of eCases with simulated real-life situations is a practical approach to address limitations of our program. It may also provide additional learning benefits for the students.

The use of the web in Pharmacy cases is not new at CUHK. In an earlier study, Lam, AuYeung and McNaught (2007) reported the compilation of case scenarios on six patients with each having a different disease topic as the focus. The teacher used the web to provide information on the patient case scenario to the students. Students were asked to do an individual task and a group task. First, each student needed to work out the appropriate treatment recommendations individually. Then, students would post their individual work on the web for exchange and further discussion with group mates who had worked on the same case. Finally, students presented the discussion outcomes as a group in class. The study provided evidence of learning benefits in areas such as self-managed learning, problem solving and better time management within and outside the classroom.

The main thrust of this paper is to further investigate the effect on learning if the students are given the responsibility to create the eCases themselves. Peer learning in a Chinese context works well once the issue of who has authority to provide 'the answers' to academic questions is negotiated. Hong Kong is still a traditional teacher-dominated education system and thus we hoped that the eCase project might develop students' ability to take ownership of their own learning through bearing the responsibility of designing questions and providing answers that are well-supported by established evidence and references.

THE DESIGN OF THE PROJECT

A case-based learning module should resemble authentic patient cases. The student-developers were asked to create patient cases of various scenarios and ask questions related to the knowledge scope of a pharmacist in practice. In addition, they should supply rich constructive feedback that is individualised according to the student-learners' answers. The aims of the project are to:

1. enhance students' abilities to apply theoretical knowledge acquired from lectures to real-life situations;
2. help students integrating various disciplines in pharmacy curriculum;
3. familiarise students themselves with clinical presentations and management of common disease states; and
4. identify the important features of an effective case-based module from students' perspective for future development.

The student-creation project included a preparatory phase, a pilot development phase and a full-scale development phase. At the point of writing this paper, the preparatory phase and the pilot development phase were completed.

In the preparatory phase, the two student-developers for this project attended a hospital-based clinical clerkship with their classmates for 9 weeks. The clinical clerkship is a regular course for year 3 pharmacy students in our program. During clerkship, students spend 4 days a week in a teaching hospital and participate in a variety of patient-related activities. Performing 'drug therapy review' for hospitalised patients is one of their core daily activities. All the cases reviewed by students were written up as case assignments and presented to teachers and classmates during regular pharmacy rounds. The role of the two student-developers in the preparatory phase was to identify patient cases with educational value for further development in the pilot phase.

Drug therapy review is a traditional learning activity for pharmacy students. Students can gain an in-depth understanding of drug use in various situations during the process. The drug therapy review involves three steps: data collection, drug therapy assessment and care plan formulation. For data collection, students collect the necessary subjective and objective findings on a patient for therapy assessment. For example, in a patient with asthma exacerbation, students should note any subjective finding such as breathlessness, and any objective finding such as peak expiratory flow rate. Other data such as past medical history, drug treatment and allergies are also important to note for therapy assessment. For drug therapy assessment, students should comment on the appropriateness of drug use considering efficacy, safety, convenience and cost factors. This step requires students to analyse various aspects of the drug regimen thoroughly, such as the drug selected for use, dosage, administration frequency and drug-drug interactions potential. Upon completion of drug therapy assessment, students summarise the assessment findings and formulate a corresponding care plan. The care plan may include recommendations to address any drug-related problem identified or further action such as patient counseling to ensure safe and effective use of drugs. All assessment findings and recommendations need to be justified with evidence and reference support.

In the pilot development phase, which has just been completed, the two student developers converted several patient cases encountered during clinical clerkship into practical eCases for teaching and learning. The primary objective was to develop a pilot small-scale prototype case-based learning module and to identify the best way to deliver such a module from the students' perspective. The case module is composed of two sections – laboratory interpretation and disease management. The laboratory interpretation section provides brief information on the clinical use of specific test and principles on interpretation. Then, two practical cases that illustrate the principles discussed are provided for students to work on. Renal function test, liver function test and arterial blood gases were included in the pilot phase as a start. The disease management section focuses on the disease topics covered in the year 2 'pharmacology and therapeutics' course in our undergraduate pharmacy curriculum. There are 22 disease topics in the course. In the pilot development phase, three commonly seen disease topics, namely asthma, chronic obstructive pulmonary disease and diabetes mellitus, were included as a start. Two cases of different patient scenarios were developed for each topic. Each

case was also supplemented by ancillary learning materials such as established disease management guidelines or clinical trial evidence.

The full-scale development phase began in June 2008. A total of 14 pharmacy students were recruited to take part in this phase as student developers. Students who take part in this phase must have successfully completed the year 2 pharmacology and therapeutic course. All students are paid for their work done based on the number of cases they develop for the project. The aim of this phase is to develop eCases on the remaining 19 disease topics covers in the pharmacology and therapeutic course. For this phase, the patient case information is generated from over 200 case assignment records collected from clinical clerkship students over the years.

This paper examines the results of the first two phases. The data reported mainly came from three sources. First, the two student-developers wrote a reflective report at the end of their pilot development on their thoughts about designing online pharmacy cases. Second, a focus-group meeting was held between them and the researchers. In the meeting, the student-developers reflected on the learning benefits they gained through engaging in the work. Third, opinions were sought at the end of the development about the learning potential and the suggestions for improvement from a group of 55 students in the same student cohort as the student-developers. The student-developers introduced the eCases to their peer students, invited them to have hands-on experience, and then administered an opinion questionnaire under the supervision of the researchers.

The process was designed to be interaction-rich. The student developers learned from the student users when the eCases were put into trial use. During the eCase development process, there were many interactions between the subject teacher and the student developers. There was also regular assistance from another consulting teacher who assisted the student developers on IT matters. Three formal meetings were held in which the teachers and the students talked about eCase design, how best to write instructions, the use of the eLearning platform, evaluation strategies and interpretation of evaluation results. During development, the student developers also consulted their fellow classmates informally on their opinions about the eCases.

Our research questions focused on whether student-creation of learning materials can benefit both the student-developers and their peer-students. The research questions are:

Q1. What have the student-developers learned from the experiences?
Q2. What was the peer-students' perceived learning potential of the case-based module?

FINDINGS

The student-developers

The two student-developers were very positive about the eCase production tasks. They regarded the tasks as meaningful and beneficial to both themselves and their peer-students. The eCase development had a range of benefits. Their knowledge growth was the strongest benefit. The student-developers mentioned that developing learning materials required them to understand the material at a much

more advanced level than they would attain if they were 'ordinary' students. They studied many additional references and reading materials in addition to those taught in class or suggested by the teacher. In this way, the self-learning extended the teaching and learning in the normal curriculum.

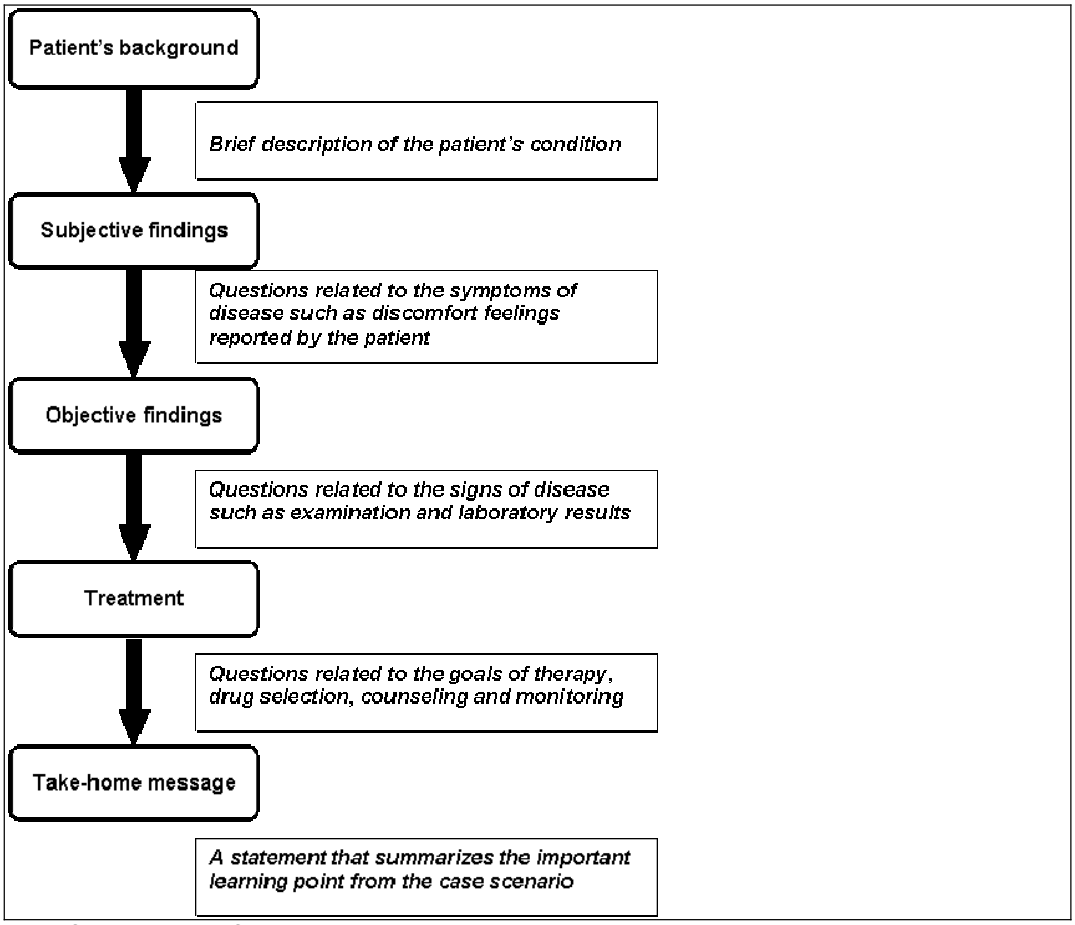
Even if some of the content was covered in lectures, they still regarded that the self-learning they had done, driven by the need to write up the learning materials, had given them a much deeper understanding. They could see the relationship between the abstract concepts of the course and the problems in the real scenarios. Very often, in order to develop a sound solution to a case, they not only called upon concepts taught in one course, but also needed to interlink the concepts and theories from a number of other courses. In this sense, the self-learning also consolidated the normal class teaching.

Apart from the knowledge gain, the student-developers also mentioned acquiring many skills, the most obvious being the skill to use the learning management system (Moodle).

The students also learnt to think from the teacher's point of view. They learnt to pay attention to the most common misconceptions held by students and then wrote questions and feedback sections to address them. They thought that tackling the most common mistakes is an effective way to teach. They also learnt how to present the teaching and learning materials in an effective manner on the web.

Furthermore, they learnt to address clinical problem in the patient scenario in a systematic manner. In the self-reflection document, they outlined the general flow design for each case. This flow design used was logical and consistent with the thinking processes of a pharmacist when dealing with a patient case. The flow design composed of five sequential steps as illustrated in figure 1. The eCases developed incorporated corresponding information and questions for each step. This design can guide the learners to analyse the patient information in a systematic manner and make recommendation at various decision points.

Figure 1



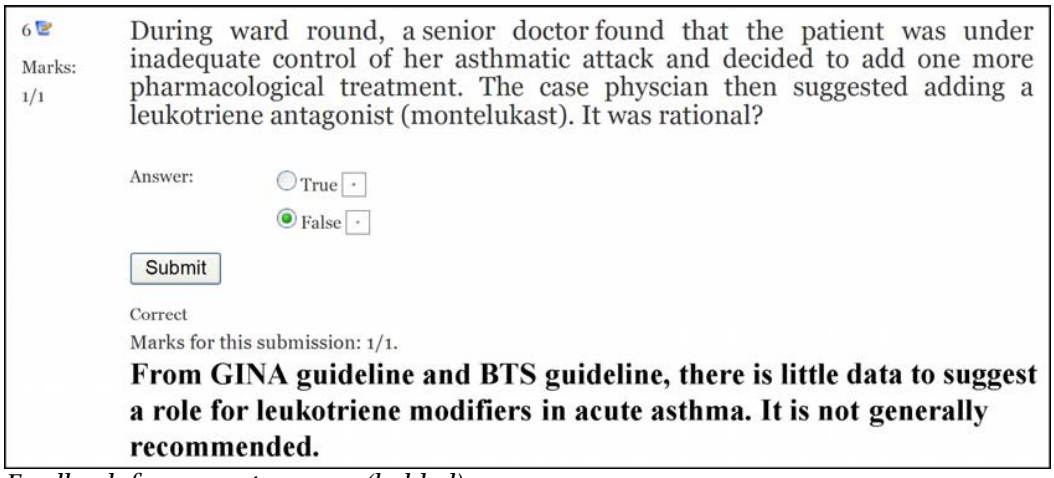
The flow design of case scenario

The student-developers also learned instructional design. They read modern educational concepts. In particular, they found the suggestions of Kaufman (2003) useful, including that learners should be active contributors to the educational process; learning should be closely related to understanding and solving real-life problems; learners' current knowledge and experience need to be taken into account; learners should be given opportunities and support for practice, accompanied by self-assessment and feedback; and learners should be given opportunities to reflect on their practice. These principles have influenced the design of the eCases such that they are rich in feedback and opportunities for learners to reflect on their own progress through self-assessment.

The teacher-student interactions also taught the students about key aspects that need attention in designing and writing eCases. Both the laboratory result interpretation cases and the disease management cases are automated and emphasise clinical application of therapeutic knowledge. Instant and specific feedback was provided for both correct and incorrect answer selection to emphasise the correct concept or explain misconceptions (see figures 2 and 3). Upon completion of the entire case, a take-home message is shown as an overall

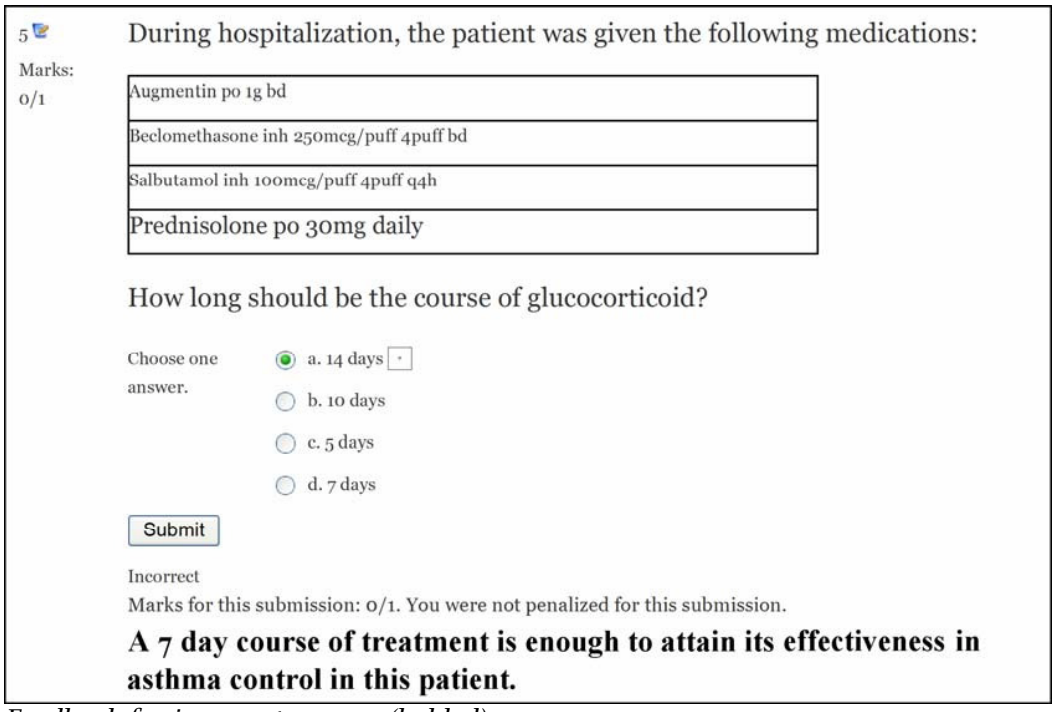
feedback to students to highlight the key learning point of the case (figure 4). Additional resources such as online resources (e.g. practice guidelines) and journal articles are provided for further in-depth reading on management of each disease state. Forums are set up for discussion of problems encountered in the cases as well as controversial issues on each topic.

Figure 2



Feedback for correct answer (bolded)

Figure 3



Feedback for incorrect answer (bolded)

Figure 4

Started on:	Wednesday, 23 July 2008, 04:38 PM
Completed on:	Wednesday, 23 July 2008, 04:39 PM
Time taken:	34 secs
Raw score:	4.53/12 (38%)
Grade:	3.78 out of a maximum of 10
Feedback	**The importance of using oral steroids in COPD exacerbation for at least a week should be born in mind. Long term use of oral steroids has to be evaluated.**

Take-home message for the case (bolded)

Not only did the student-developers learn how to design learning materials, they also learnt how to present the materials in an effective manner. The student-developers followed the effective webpage design principles put forward by Cook and Dupras (2002) as they designed the content layout for the module. The principles specify that page organisation should be clear and consistent, text should be concise and able to facilitate scanning, topics should be summarised before presenting the details, headings should be clear, length of paragraphs should be short, web space should be used wisely, and unnecessary graphics or animations should be minimised. The opinions the student developers obtained from their peers from time to time also helped refine the presentation.

The student-learners

Year 2 and year 3 undergraduate pharmacy students at CUHK (55 students in total, excluding the two project student-developers) were invited to try out the pilot case-based module on a voluntary basis over a two-week period. The usefulness and acceptance of the case module were evaluated by a questionnaire incorporated in the web module. Student-learners completed the questionnaire after trying out the module.

Objectives and a brief description of the module were clearly stated and the student-learners were strongly encouraged to finish the questionnaire in order to give us feedback for improvement. The questionnaire contains 11 statements that students were asked to assess on a five-point Likert scale ranging from '1 = strongly disagree' to '5 = strongly agree'. The mean score was calculated for each question. In addition, two open-ended questions were set.

The enthusiasm of the student-learners in trying out the eCase module was less intense than hoped. From the activity report of the Moodle system, the frequency of login from the generic account was satisfactory during the trial period. However, only a few number of students completely attempted the case scenarios. The majority of students only skimmed through the cases.

The response rate for the questionnaire was also low. Seventeen out of 55 students (31%) completed it. The questionnaire results are presented in table 1. The opinions collected, though not representing the majority of students, were on the whole very positive. The majority of students who completed the survey strongly agreed or agreed that the learning module is relevant to pharmacy practice (89%, mean score=4.12) and can foster their improvement of knowledge in this aspect (77%, mean score=4.00). Many of these students thought that the cases assisted them to integrate lessons learnt from basic and clinical science into practice (82% strongly agreed or agreed, mean score=3.88). The feedbacks from cases and the clinical guidelines provided were felt to be useful (mean score = 3.88 for Q5 and Q7). However, the interface of the learning module was not considered to be very user-friendly by the students. The interface only allowed students to see their overall score performance. It did not adequately assist students in understanding their own weaknesses. This is reflected by the mean score of 3.65 for the two relevant questions (Q1 and Q9); this is the lowest mean with a relatively higher proportion of students that disagreed. Overall, the learning module was considered useful to learning in the view of students (83% strongly agreed or agreed, mean score=4.00).

Table 1

Q	Questions	Mean Score* (SD)	Percentage and number of respondents with respect to each option									
			Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
1	The learning interface is easy to use.	3.65 (1.06)	6%	1	65%	11	18%	3	12%	2	0%	0
2	The laboratory interpretation module enables you to learn the basic knowledge of this aspect.	3.88 (0.70)	29%	5	35%	6	29%	5	6%	1	0%	0
3	The cases enable you to integrate basic and clinical science into practice.	3.88 (1.30)	6%	1	76%	13	18%	3	0%	0	0%	0
4	The cases have fostered improvement of knowledge.	4.00 (0.89)	24%	4	53%	9	24%	4	0%	0	0%	0
5	The feedback you got from the cases is useful.	3.88 (0.74)	24%	4	41%	7	35%	6	0%	0	0%	0
6	The questions in the cases are clear.	4.00 (1.29)	12%	2	76%	13	12%	2	0%	0	0%	0
7	The clinical management guidelines provided are useful.	3.88 (1.06)	12%	2	65%	11	24%	4	0%	0	0%	0
8	The cases are relevant to pharmacy practice.	4.12 (1.10)	24%	4	65%	11	12%	2	0%	0	0%	0
9	The cases let you better understand your own weakness.	3.65 (0.93)	12%	2	59%	10	12%	2	18%	3	0%	0
10	The take-home messages are useful.	3.71 (1.00)	6%	1	59%	10	35%	6	0%	0	0%	0
11	Overall, this module is useful to your learning.	4.00 (1.07)	18%	3	65%	11	18%	3	0%	0	0%	0

Summary of questionnaire results

In addition to the close-ended questions in the questionnaire, two open-ended questions were asked, with one focused on general opinions about the learning module and the other on improvements needed. The general comments were, on the whole, positive and echoed the tone of opinions in the closed-ended questions:

- "The case-based quizzes allow students to apply textbook knowledge and for self-learn."
- "The cases are interesting and are similar to exams."
- "The information provided is easier to understand than in textbooks, but may be not in-depth."
- "The lab interpretation part is useful in the clinical setting."
- "The module is generally well-established."

There were also suggestions for improvement but they seemed to be relatively minor. For example, they suggested:

- "The basic patient information in the cases should be shown on the same page as the questions for easy referring."
- "Correct answers should be provided since some feedbacks do not clearly state them."
- "More cases and more disease states have to be included."
- "Hyperlinks to online standard textbooks and drug references have to be included for convenience."

DISCUSSION

Learning potential for the student-developers

What have the student-developers learned from the experiences? We found that students learnt both knowledge and skills when they contributed to the development of course materials. The findings are in line with the other findings in the literature that students can learn more through taking the role of teachers (e.g., Topping and Ehly, 2001). Similar learning advancement seemed to be evidenced in the present study even if the teacher role taken up by the students was partial – that of learning material development.

The student-developers remarked that they had better understanding of the theories and concepts they were responsible for. They also recognised more clearly the interrelationship between concepts learnt at different stages of their study because often multiple concepts are involved in real-life situations.

Learning of important skills was also evidenced. The student-developers were more able to appreciate the design of learning materials from the perspective of teachers. They have developed the skills to design pedagogically sound instructions. The web-based development has also enhanced the students' computer skills.

In the coming pharmacology and therapeutic course, other students will be required to work through the eCases created by the student-developers. These students should enjoy the learning benefit of applying theoretical knowledge from lectures into real situations. The student-developers, however, strongly felt that

the learning benefits involved in actually designing and developing the eCases is not comparable to that gained by students merely working through the cases.

Learning potential for the student-learners

Compared to the student-developers, the benefits to the student-learners were less apparent in this study. We observed a lack of enthusiasm on the part of the student-learners.

This may be due to the presence of several hindrances during the trial period. The main one was the suboptimal timing selected for the trial. The student-developers spent the majority of the school term in designing the cases and setting up the web platform. As a result, the trial time was held close to the end of term when all students were busy with their own studies. It is not surprising that we got such a low response rate. Each case scenario consists of about 10 questions and normally requires 15 to 30 minutes to complete. This amount of time may be considered as substantial in this busy period if students go through each case thoroughly. Moreover, as the case-based module was designed as an adjunct tool to supplement traditional lectures, it will be more attractive to students if they are having the associated lectures in the course concurrently. In the trial, students who participated have already taken the course for which the module is designed in the previous term. Finally, participation in the trial was voluntary. Thus, there was a lack of incentive to motivate participation.

Student-learners' comments about the eCases were on the whole positive. The common positive feature is having detailed feedback. Inclusion of both local and international guidelines on the issues was welcomed by the students. The students also appreciated the balance of both practical and theoretical questions. Overall, the direction of the pilot case-based module seemed to be appropriate.

Future directions and improvements

The case-based learning module is only in preliminary stage. About the future direction of development, the laboratory interpretation section should be expanded because those topics are not well-covered in lectures and students find the material useful. The disease management section should also be expanded to cover more disease topics. Moreover, more detailed feedback is preferred by students for in-depth understanding.

As mentioned before, the next phase of the project is to recruit more student-developers and to produce more eCases which cover more disease topics. In early June 2008, a first gathering was held in which the two student-developers in the pilot phase shared their experiences with the new developers in a very fruitful exchange. Together, they came up with even more ideas for improvement in the next phase, such as:

- To tackle the problem of language errors, the Independent Learning Centre at CUHK could be consulted. Services should be sought for proofreading and correcting the information in the learning module before publishing to improve the clarity of information.
- Hyperlinks of drug reference and references to standard textbooks, apart from journal articles, should be provided for quick checking.
- An introductory session on the Moodle system can be provided to the students to assist them to become more familiar with its functions and usage.

The experience further strengthened our belief that students can contribute to learning materials development. They can appreciate the learning benefits and can be motivated to spend time on the work. However, teachers' guidance is also important to advise on the development of quality work. With appropriate guidance, student-created learning materials can be better than teacher-created work. In our study, for example, the student-developers regularly consulted their fellow classmates during the development. Such teacher-student dialogue would be less likely to occur when teachers are writing the courseware. The communications enabled the student-developers to more accurately target the needs of the students.

CONCLUSION

This paper reports an investigation into the learning benefits derived from engaging students in the development of Pharmacy eCases. The student-developers, whose work was one form of peer-teaching, clearly felt they had learnt a great deal in terms of knowledge and skills. The benefits for student-learners were not apparent in the present study because the trial eCases were not integrated into the formal teaching in the course. However, the student-learners affirmed the overall design for the module and perceived its potential benefits on improving their knowledge in the pharmacy practice.

The present study is a small scale pilot study in nature. The experience and students' inputs will influence the full-scale development phase of eCases. The next group of 14 student-developers is now better equipped and has a clearer understanding of the needs of student-learners. The researchers believe that our overall strategy will bring learning benefits to future students-learners in our pharmacy program.

ACKNOWLEDGEMENT

We thank the student-developers Mr. Law Wai Lam and Mr. Yip Ho Wa for their dedicated contributions to this project.

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