Pharmacy Education, December 2007; 7(4): 341–349

Use and evaluation of "virtual" patients for assessment of clinical pharmacy undergraduates

J. L. MARRIOTT

Department of Pharmacy Practice, Victorian College of Pharmacy, Monash University, Parkville, Victoria, Australia

Abstract
As an assessment task, third and fourth year undergraduate pharmacy students choose their own individual "virtual" patient using a purpose-designed computer program and respond to a clinical scenario that is randomly allocated to their individual patient according to defined limits. This then forms authentic teacher and peer-assessed, case-based assignments designed to evaluate clinical skills in undergraduate pharmacy students. Large numbers of students can be managed efficiently using the virtual patient program. The assignment has been completed by up to 360 students per year. The development of an authentic assessment tool has proven useful for the assessment of large numbers of undergraduate pharmacy students and is educationally sound. Students also interacted well with the program and felt it contributed to their learning. An evaluation questionnaire was completed by 212 students who reported that the assignment was relevant to the subject and the assessment improved their learning.

Keywords: *Pharmacy, assessment, case-based assessment, virtual patients*

Introduction

Learning has been described as a dynamic process that involves the acquisition of knowledge and skill to achieve complex understanding (Moskal & Leydens, 2000). In the context of a Bachelor of Pharmacy degree it is essential not only to develop specific practical skills, but to use the skills to apply knowledge in a clinical context. Assessment of the degree to which students have developed clinical skills and are able to apply their knowledge is a fundamental part of the learning process, and this assessment should be designed to measure both problem-solving abilities, and the knowledge and understanding of concepts (Moskal & Leydens, 2000). Conventional, exam-based assessment methods do not adequately fulfil this task (Hargreaves, 1997; Brown & Craig, 2003). Poorly designed assessment can encourage students to undertake "surface learning" utilising rote-learning of a body of information, rather than "deep learning" where students apply their knowledge in a more realistic problem-solving situation (Hargreaves, 1997).

Authentic assessment is a form of performance assessment that requires students to demonstrate certain knowledge and skill development while connecting theory and practice in an authentic context (Wiggins, 1990; Kerka, 1995; Moskal & Leydens, 2000; Brown & Craig, 2003). Authentic assessment accounts for individual learning styles and cultural differences and requires students to apply cognitive skills and understand the nature of high quality performance (Rudner & Boston, 1994). In pharmacy education an authentic context includes patient or problem-centred assessment.

Assessment of clinical skills should include components that evaluate the learner within the clinical context (Adamcik & Stimmel, 1989). Integral to the assessment should be feedback to the student about their level of skill attainment and what further knowledge and skills are required. Assessing the

Correspondence: J. L. Marriott, Department of Pharmacy Practice, Victorian College of Pharmacy, Monash University, 381 Royal Parade, Parkville 3052, Victoria, Australia. Tel: 61 3 9903 9533. Fax: 61 3 9903 9629. E-mail: jennifer.marriott@vcp.monash.edu.au

ISSN 1560-2214 print/ISSN 1477-2701 online
DOI: 10.1080/15602210701673795

management of clinical scenarios provides a valuable learning opportunity as well as an authentic method of evaluating knowledge and skills. Assessment tasks should also provide problems that require higher-order thinking, scoring procedures that allow equity and opportunities for self-evaluation (Kerka, 1995). Authentic assessment achieves validity and reliability by standardising the scoring criteria for varied responses (Wiggins, 1990).

The use of clinical case studies, simulation of real or life-like situations to provide authentic assessment of clinical skills, such as those required of practising pharmacists, enables students to demonstrate knowledge and clinical reasoning skills (Oliver, 1997; Oermann, Truesdell, & Ziolkowski, 2000; Conyers & Ritchie, 2001). It also tests their ability to organise and assess information, and encourages critical thinking rather than simply memorising facts (Oliver, 1997; Oermann et al., 2000; Conyers & Ritchie, 2001). The use of case studies can allow assessment to focus on problems more likely to be encountered in real practice which increases its relevance to the student's learning (Maclellan, 2004). While there is increased use of clinical cases and scenarios for assessment in pharmacy and in other health professional education (Oliver, 1997; Schuwirth et al., 1999; Conyers & Ritchie, 2001), when there are large class sizes the exercise may be difficult and time-consuming to coordinate, and the potential for plagiarism may limit their value. The amount of time spent developing cases can be prohibitive, as can the complexity associated with assessing the task.

Clinical pharmacy is taught to pharmacy students in the final years of the Bachelor of Pharmacy degree at Monash University, Australia. It aims to develop student's understanding of drug therapy principles in particular patient groups and the provision of clinical pharmacy services. Students develop a patient-centred view of health care delivery and understand the role of the pharmacist in patient management. A method of assessment designed to be interesting, challenging and meaningful has been introduced into the subject; it uses a case-based assignment to closely reflect subject objectives. The assessment was developed to cover a range of clinical problems that students are likely to encounter in their future clinical practice.

Peer assessment

Peer reviewing skills are an essential component of professional and academic life. Students need to develop skills that will allow them to assess the quality of work of subordinates, peers, superiors and themselves (Zariski, 1996). Peer assessment has the benefit of involving the student in the learning process by encouraging them to practise assessment, develop critical thinking skills and recognise defects in their own work (Zariski, 1996; Hargreaves, 1997; Flachikov & Goldfinch, 2000).

Students may encounter a number of problems when being involved in the assessment of others. Some students may struggle to criticise the work of a peer or may be concerned that a peer may give them a "bad mark", may have difficulty identifying relevant grounds for criticism or may not recognise errors in another student's work. Students will probably have a decreased understanding of the subject compared with the teacher (Bond, 1996; Zariski, 1996). Students provided with appropriate assessment criteria should, however, be able to provide valid and reliable assessments (Macpherson, 1999; Flachikov & Goldfinch, 2000).

Criterion-referenced assessment

Criterion-referenced assessment compares a student's knowledge and ability against a set of pre-determined criteria; it does not directly compare one student with another (Bond, 1996). The criterion-referenced assessment features a stated objective, a rating scale and specific performance characteristics ranging in degree to which the standard has been met (Kerka, 1995; Brown & Craig, 2003). The resultant score of the criterion-referenced assessment can be standardised using a uniform scoring procedure and then included as part of summative assessment (Bond, 1996; Moskal & Leydens, 2000). Specific criteria provide a framework that ensures the assessment is fair, ethical and valid; highlight important outcomes to the student; and document progress (Wiggins, 1990; Moskal & Leydens, 2000). The criteria must reflect expected student standards and specify learner's performance expectations (Kerka, 1995; Moskal & Leydens, 2000). In authentic assessment situations students are alerted in advance to evaluation criteria so that they are aware of the expected achievement standard.

"Virtual" patient program

The use of a virtual patients program aimed to develop an authentic assessment method to improve student's learning experience and develop critical thinking skills. The virtual patient program is a computer program that provides access to a list of "virtual patients" to which a range of clinical scenarios can be applied to develop individual case-based assignments. The assessment uses these clinical cases, a criterion-referenced marking scale and provides both summative and formative assessment by peers and tutors of an oral case presentation.

This paper describes the use of the virtual patient program for assessment of undergraduate pharmacy students and evaluation of it by students.

Table I. Criterion-referenced assessment guide.

Criteria	0 marks	1 mark	2 marks	3 marks	4 marks	Mark
All relevant details of the case is presented with comments concerning appropriateness but without recommendations for change unless clearly dangerous or related to scenario	No patient history is presented	Only basic patient information presented with no comment on appropriateness of current treatment	Basic information is presented with minimal comment on appropriateness of current treatment	Information is presented with linking of indication and treatment and comment on appropriateness		
The disorder is correctly diagnosed with consideration of differential diagnoses and an indication of how decisions are made	An incorrect diagnosis is made with no differential diagnosis or justification	An incorrect diagnosis is made but differential diagnoses considered are reasonable or adequate justification is given	A correct diagnosis is made but it is not supported by clinical reasoning and differential diagnoses	A correct diagnosis is made based on clinical evidence but inadequate consideration is made of differential diagnoses	A correct diagnosis is made with appropriate consideration of differential diagnoses	
Correct treatment for the condition is outlined. If a decision is made to refer the patient this must be justified and an indication made of what treatment would be expected.	Treatment for the diagnosis made by the student is incorrect or is not provided or the patient is referred to the doctor without explanation	Treatment for the diagnosis made by the student is incorrect in most areas or the patient is inappropriately referred to the doctor	Treatment for the diagnosis made by the student is incorrect or is incomplete OR treatment for the diagnosis made is correct or mostly correct, although the diagnosis itself was not correct	Treatment is provided for the correct diagnosis but is incomplete	Treatment outlined is correct and complete	
Age of patient is considered when determining appropriate treatment when relevant	The age of the patient is not considered in determination of appropriate treatment	The age of the patient is considered in determination of appropriate treatment or is not relevant				
Existing medical conditions of the patient are considered when determining appropriate management of the condition	The existing medical conditions of the patient are not considered in determination of appropriate treatment	The existing medical conditions of the patient are given only minor consideration in determination of appropriate treatment	Some of the existing medical conditions are considered appropriately, but others are omitted	All existing medical conditions of the patient are fully considered in determination of appropriate treatment		
Current drugs being taken by the patient and the effect of those drugs on current therapy is considered when choosing appropriate drug treatment	The current medication taken by the patient is not considered or decisions made are incorrect in determination of appropriate treatment	Some of the current medication taken by the patient is not considered in determination of appropriate treatment but decisions are correct	All current medication taken by the patient is considered in determination of appropriate treatment but some incorrect decisions are made	All current medication taken by the patient is fully considered in determination of appropriate treatment and correct decisions are made		
Counselling provides all appropriate information with regard to the condition and its treatment with consideration of patient characteristics, e.g. Age, prior medical history, other medication	Counselling for the patient is not provided	Counselling for the patient is provided but is brief or confusing in nature and does not take into account relevant patient characteristics	Counselling for the patient is provided but does not take into account relevant patient characteristics	Counselling for the patient is provided but only includes consideration of some relevant patient characteristics or information is not prioritised	Counselling for the patient is provided taking into account all relevant patient characteristics and is prioritised	

Table I – *continued*

Criteria	0 marks	1 mark	2 marks	3 marks	4 marks	Mark
The presentation was delivered in a clear manner and in a logical and easily understood sequence using appropriate visual aids	The presentation is poorly delivered or is presented in a confused or unclear manner	The information was over time by >2 min	The case and its treatment were delivered in a logical and easy to follow sequence but delivery was not clear or was boring or monotonous	The case and its treatment were delivered in a clear, concise manner, in a logical and easy to follow sequence		
Feedback comments for student						/25

Method

Utilising a purpose-designed computer program the students selected a standardised virtual patient from a database of over 200 potential patients. Students had access to the patient's age, gender, smoking and allergy history, up to four medical diagnoses, the patient's medication regimen which included up to six medications and test results (where applicable). Upon patient selection, a randomly allocated clinical scenario particular to the patient was accessible to the student. Up to 48 clinical scenarios describing a range of respiratory and dermatological conditions were developed based on typical disease states that affect patients at a range of ages. To assist in the diagnosis, the dermatological scenarios were accompanied by a photograph depicting the visible symptoms on the affected area of the body. Students are given 6 weeks to complete this assignment.

As part of the assessment, students were required to consider the individual characteristics and medical history of their virtual patient and make a provisional diagnosis. They were then required to determine an appropriate management plan in response to the symptoms and the applied scenario, including counselling information tailored to their virtual patient's needs. The program allowed for students to retain their patient across 2 years of their course, with a new scenario applied in the second year. Over the 2 years of the clinical pharmacy units students use this program once a semester as part of their assessment.

The student's response to the clinical scenario was assessed during an oral presentation of their case to two independent tutors and an allocated group of 10–12 peers. Each group contained a mix of scenarios that exposed students to a range of clinical situations. Students were required to prepare their presentation on transparencies for use with an overhead projector. Due to the large numbers of students involved and the limited time available students do not have the opportunity to practice before a tutor prior to assessment, but as friends they do gather informally in practice groups. Although presentations in front of a group only form part of the assessment in each year's second semester with students receiving written feedback on the responses to the scenario in the first semester.

The student's response to the clinical scenario was assessed according to a criterion-referenced marking guide (Table I) that indicated the expected level of response. The criterion-referenced marking guide was developed to reflect the major assessment elements required for the assignment. These criterion reflect the main elements of clinical problem-solving—understanding the patient's presenting symptoms, making a clinical judgement concerning diagnosis while considering other possible diagnoses, determining appropriate patient management based on individual patient characteristics (age, medical

conditions and medication) and providing information to the patient.

A mark was also given to reflect presentation skills. Marks were allocated for student input into each step in this process. Making a correct diagnosis was therefore given five possible grades, however, consideration of age was given only two—with the option that it either was or was not considered. The wording on the marking guide was developed iteratively based on feedback from assessing tutors. The guide increased transparency of the marking process and reliability both between the two tutors marking each group and between groups. Students were provided with the marking criteria in advance, but only received the full criterion-referenced assessment guide at the presentation. In addition to tutor markers, students assessed their peer's responses according to the same assessment criteria.

On completion of the assessment students were asked to complete a survey (Table II) to determine the program's ease of use and its perceived value. The anonymous survey was made available to 360 undergraduate students via the unit web page and at the time of assignment presentations. Tutor marks for each student were compared with the average mark awarded by the student group. The marks awarded for a group of 164 fourth-year students were compared using a paired *t*-test to compare marks for each student between tutor and to compare the tutor mark with the peer mark for each student.

Quantitative analysis of closed questions was performed using Microsoft Excel to obtain mean values for Likert scores and standard deviations. SPSS v15.0 (SPSS Inc.) was used to conduct statistical comparisons. A p value >0.05 was considered significant. Response to the open-ended questions was analysed for common themes using an NVivo® database (QSR NVivo; v2.0, QSR International) using two researchers to ensure consistency of coding.

Results

Students in the third or fourth year of the Bachelor of Pharmacy course at the Victorian College of Pharmacy (VCP) completed the assignment as part assessment for the Clinical Pharmacy units of the four-year undergraduate degree. A 2004 survey of the student body indicated that of the predominantly female student cohort (68%) 59% were born overseas and 86% had parents who were born overseas (Roller, 2005). Patients of third year students were allocated respiratory scenarios and patients of fourth year students were allocated dermatological scenarios. Student-specific assignments were generated for all students. The students were able to access the assignment database, and complete the task appropriately within their level of capability. The average assignment mark for the group who have completed the assignment over the past 2 years is 79%.

Two hundred and twelve students returned the survey, a response rate of 58.8%. As the surveys were anonymous information about the student (name, ID number, gender and year of course) was unavailable.

Table II. Student survey with mean results for quantitative responses.

For the *Clinical Pharmacy Case-based Assignment* you were required to access the Computer Program via WebCT, login and choose a patient. The following questions relate to that component of the program 1 = very hard; 2 = hard; 3 = neither easy or hard; 4 = easy; 5 = very easy	1	2	3	4	5	Mean response (± SD)
How easy was it to locate the assignment?						4.33 (0.9)
How easy was it to log in and open the program?						4.39 (0.9)
How easy was it to choose an appropriate patient						4.00 (3.7)
Approximately how long did this process take you?		... minutes				13.51 (12.80) mins
How easy was it to locate the scenario that was applied to your patient?						4.11 (1.04)
How easy was it to print or save the information you needed for your assignment?						4.26 (0.98)
How easy was it to locate your patient/assignment the second year?						3.91 (0.98)
What did you think of the process of selecting your own patient?						
What is useful to have the same patient 2 years in a row?						
What are your views concerning this case-based "virtual patient" assignment?						
Please rank 1–5 with 1 = least; 5 = most						
The assignment was relevant to the subject?						4.39 (0.75)
I was able to learn more about the subject by doing the assignment						4.05 (0.89)
Having a unique patient helped my learning						3.93 (0.89)
Presenting the information to others improved my knowledge of the subject						3.64 (1.00)
Presenting the information to others improved my communication skills						3.97 (0.99)
Presenting the information to others improved my confidence						3.75 (1.09)
Undertaking peer assessment was new to me						2.33 (1.31)
Undertaking peer assessment encouraged me to listen to the other presentations						3.38 (1.03)
Undertaking peer assessment helped me learn from other students						3.41 (1.11)
The criterion-based assessment sheet was useful						3.63 (1.10)
What would improve the assignment?						

Table III. Qualitative comments from students regarding the assignment.

Theme	Representative student comments	
	Positive views	Negative views
Self-selection of patient	"It's good because you get to choose what you want, and who you want, so you feel a bit better and you actually want to do the assignment"	"You don't get to choose your patient in real life" "People who left it longer to select a patient got the "harder" patients"
Having the same patient for 2 years with different scenarios added for each assignment	"This was very useful as you were already aware of your patient, any co-morbidities which they may have had and the medication which they were taking" "It taught you to selectively pick out info that may not have been relevant in the first year but was applicable in the second, and vice versa."	"It would be useful to be exposed to different [patient] complications"
General value of the assignment	"Overall, the assignment was an enjoyable, interesting, challenging and a very valuable teaching and assessment tool. It taught me to really understand what clinical pharmacy was about, and the style or approach to take in everyday practice" "It stands out as one of the most enjoyable informative valuable and educational assessments in my entire experience"	
Recommendations regarding use of the assignment	"This assignment was really useful and should be used more often"	"Split presentation group into even smaller group" "Maybe just have the tutors"

Results of the quantitative survey questions are reported in Table II and representative student comments in response to the open-ended survey questions shown in the survey form in Table II are presented in Table III. The students generally valued the assignment as relevant to the subject, beneficial to their learning and different from their usual methods of assessment.

The process of patient selection

Respondents reported that the assignment program was easy to access and patient selection could be negotiated relatively quickly (Table II). The ability for the student to self-select their patient was considered an innovative and convenient method of assignment allocation that added a dimension of reality to the assignment, but did not negatively affect the resultant quality of the work.

Once patients were selected by a student, they became unavailable to subsequent students. There was some concern that students who chose patients later than others were left with a limited choice and more difficult patients, but as patients were standardised, this was an inaccurate perception. Some students also felt that having so many patients to choose from made the process more difficult as they read through each patient before making a choice which was unnecessary. These students felt that random patient assignment would work equally well and be equally realistic.

Student self-selection of patients created a phenomenon where some students developed a "relationship" with their virtual patient, creating for them habits, occupations and in some cases even pets. The following quotes were taken from actual assignments as an indication of the way that students engaged with their "virtual" patient.

> " Mr X is a 42 year-old engineer ..." (Student SW, Male 3rd year).

> "Towards the end of the long and interesting conversation of pot plants, ungrateful children and the weather, Agnes informed me that she was also feeling very "worn out and tired", she had some oedema in the ankles and that the SOB occurred more at night and during her walks with her Newfoundland dog "Perdita"." (Student MH, Male, 4th year).

Having the same patient with different scenarios 2 years in a row was considered to add further realism to the case. As scenarios were unrelated it did not increase the difficulty of the second scenario, but may have made the second year easier as complete information on the patient's medical conditions and medication was already known. Students, however, still needed to re-consider the patient information

in the context of the new clinical scenario. Some students felt that having different patients for each assignment would increase their opportunity for learning.

General value of the assignment

Students reported that they felt the assignment was relevant to the subject being assessed and improved their learning. Comments about the assignment were generally positive, although this may have reflected the attitude of students who voluntarily opted to complete the survey. Many of the students made no suggestions for improvement of the assignment (38%). Student's suggestions for assignment improvements mainly focussed on logistical issues such as group size and presentation delivery. Students indicated a preference for presentation using a data projector rather than overhead projector as this obviated the need for purchase of overhead transparencies. Constructive comments for improvement of the assignment were generally positive, but did include suggestions for group presentations that removed or decreased peer assessment.

Peer assessment

A small number of students ($n = 5$) did not like peer assessment and some students ($n = 19$) preferred smaller groups (currently 10–12 students per group) even to the extent of only presenting in front of the assessing tutors. Students indicated that peer assessment was not new to them (rated 2.33 ± 1.31). Students used the same criterion-referenced marking guide as the tutors, and their marks were generally higher than the tutor's marks. The average mark allocated by the first tutor was 21.40, the average second tutor mark was 21.47 and the average student mark was 22.9. The difference between marks given by the two tutors for each student was not statistically significant ($p > 0.05$). There was the opportunity for tutors to explain or discuss any differences and to provide independent written and verbal feedback for the student. The difference between the mark allocated by the tutor, and that allocated by the student's peers for each student was significantly different ($p < 0.01$), although the numerical difference was not large.

Discussion

This assessment method was able to provide a unique and reasonably authentic method for the assessment of undergraduate pharmacy students because it assessed skills and knowledge that are required of a practising pharmacist in a close-to-real context which is considered important in providing an authenticity (Wiggins, 1990; Kerka, 1995). The standardised patients provided fairness for students by supplying assignments of equal difficulty.

A study of UK students revealed that 53% had participated in dishonest behaviour (Harries & Rutter, 2005). This study also showed that students were more likely to cheat in coursework than written examinations (Harries & Rutter, 2005). It has also been shown that students do not always understand what constitutes plagiarism and fail to appreciate that cutting and pasting from internet sites constitutes plagiarism, but are aware of opportunities for plagiarism and cheating (Ng, Davies, Bates, & Avellone, 2003; Bates, Davies, Murphy, & Bone, 2005). Opportunities for plagiarism between students were markedly decreased with the virtual patient assessment program. Although scenarios were duplicated at times and students may have compared information about diagnoses, individual patient characteristics needed to be considered to manage the patient, necessitating an individual response which reduced the opportunity for plagiarism (Apiwan, 2003). Equally important for plagiarism, the scenario–patient match is re-randomised each year so that patient characteristics for any particular scenario are different for every student, every year. No episodes of plagiarised material have been detected in assignments to date.

In the past, real and simulated patients have been used for student assessments. The standardised nature of virtual patients increases the validity of the assessment as each assignment is relatively consistent. The use of case studies involving any of the three types of patients (real, simulated, virtual) is the best way of assessing students' critical thinking skills.

Using real patients for assessment, however, creates problems due to the amount or complexity of information and the difficulty in having appropriate numbers of suitable patients available at a specified time. Simulated patients (people specifically trained to respond as a patient) have been widely substituted for real patients due to their greater availability and their potential to be trained to provide standard answers (Shankar, Subish, Dubey, & Mishra, 2006). The main disadvantage associated with using simulated patients are the training and usage costs involved, problems with access to sufficient numbers of people at the required time and the unpredictability of extra information that may be provided. Programs that have successfully used real patients in their programs generally involve small numbers of students (Dammers, Specner, & Thomas, 2001). The use of virtual patients is a more cost-effective and readily available method of providing patient information to students, suitable for large numbers of students accessing the information at the same time and can be reused without significant further cost. The main disadvantage with virtual patients is they lack the element of realism and cannot provide additional information in response to student's questions. The virtual patient

program provides patient-specific information only. It would be logistically and financially impractical to have real or simulated patients trained and available to provide such information to 250 students in 2 year levels twice a year. Tutors and peers can provide feedback to the student both during and after the presentation.

The use of clinical scenarios randomly assigned to the virtual patient according to pre-set limitations effectively produced case studies for specific clinical conditions. Case studies assist in promoting a deeper approach to learning and, when used in assessment, allow students to demonstrate a wide range of knowledge and skills, including critical thinking skills (Oermann et al., 2000; Conyers & Ritchie, 2001). It is difficult to assess these skills using traditional examination methods (Oermann et al., 2000). The multi-faceted nature of the assignment assesses the student's ability to make a diagnosis based on a set of symptoms, to determine treatment appropriate to that diagnosis but tailored to an individual patient's needs, to present the information clearly and concisely and to justify their decisions.

Peer assessment

Peer assessment encourages students to think critically about other student's work in relation to their own (Macpherson, 1999; Flachikov & Goldfinch, 2000) and was reported to be a process that was not unfamiliar to them (rated 2.3/5). Although students generally took the peer assessment seriously, some had difficulty assigning marks to peers and tended to assign higher marks than tutors. Even though specific marking criteria were supplied as a reference, a minority of students assigned identical marks to all students in their group. It is unclear whether this was due to laziness or unwillingness to judge a peer's work. Although the main assessment criteria for the assignment were provided to students at the commencement of the assignment, the full criteria for allocation of marks were not known in advance. This may have affected student's ability to quickly discriminate when applying marks, although the full criterion-referenced marking guide (Table I) was available for all students during the assessment of presentations and was found useful (rated 4.25/5). Providing the full marking criteria guide to the students prior to the presentation may improve consistency of marking (Macpherson, 1999).

The significant difference between the tutor assigned mark and the peer assigned mark could also be an indication the students have not developed sufficient critical appraisal skills (Macpherson, 1999). This is important and indicates an area that students need help developing; it may require a curriculum adjustment. The lack of correlation between tutor- and peer-assigned marks by may also be due to the multidimensional aspect of the marking guide that required judgements of a wide range of performance aspects (Flachikov & Goldfinch, 2000).

Engagement of students with their virtual patient

Students generally treated their virtual patient as if they were real, often inventing non-clinical information concerning their patient. This appeared to engage the student more fully in the learning experience. As the pharmacy undergraduate education places emphasis on the development of a patient–practitioner relationship to further good health outcomes, the development of a virtual patient–practitioner relationship was indeed a positive aspect of the student's engagement with the process. The ability to choose a patient that had medical conditions that were of interest to the student may also have increased the engagement of students with the assignment.

Learning outcomes

The assessment method was closely aligned to the subject's learning objectives which require a deep level of learning and application of knowledge, decision-making and skill extension to related areas. It also enabled assessment of the student's understanding of symptoms in relation to pathophysiology, treatment options and the ability to apply them in a clinical environment and the role of providing patient-specific information such as counselling.

The individual nature of the virtual patient assignment decreased the opportunity for plagiarism and this is likely to increase the learning for each student as they need to develop their own problem-solving and decision-making skills.

Limitations of this research

Survey completion was voluntary and was conducted with 2 year levels during one semester. It is possible that students in others years may have held different views. The views of those who did not respond to the survey are not known and cannot be predicted. Since the commencement of the assignment informal student feedback has been similar to the reported survey responses, with students generally valuing the assignment and making suggestions for minor modifications.

Conclusion

A large number of student assignments can be generated efficiently by using the computerised database to randomise scenarios and provide a gateway to the virtual patient list. This decreased the workload for academics without decreasing the assignment's

educational benefits. This form of assessment enables students to undertake clinical review of an individual patient chosen from a standardised database of virtual patients. The development of an authentic assessment tool that can be applied to a clinical situation has proved useful for the assessment of large numbers of undergraduate pharmacy students.

Students demonstrated an ability to apply appropriate clinical skills to individualise treatment of a range of conditions. Furthermore, student learning experiences are improved as they are required to assess both a wide range of clinical scenarios and management responses aside from their own. Students interacted well with the program and felt it contributed to their learning.

Acknowledgements

This work was funded by the Unit Innovation Grant Scheme from Monash University. The assistance of Mr Eric Goh and Mr Michael Calagasz in development of the computer program is acknowledged. Thanks to Ms Jenny McDowell for assistance in manuscript preparation.

References

Adamcik, B., & Stimmel, G. (1989). Use of physical assessment skills by clinical pharmacists in monitoring drug therapy response: Attitudes and frequency. *American Journal of Pharmaceutical Medicine*, *53*(2), 127–132.

Apiwan, D. B. (2003). How to reduce plagiarism. *Journal of Information Systems Education*, *14*(3), 223.

Bates, I. P., Davies, J. G., Murphy, C., & Bone, A. (2005). A multifaculty exploration of academic dishonesty. *Pharmacy Education*, *5*(1), 69–76.

Bond, L. (1996). Norm and criterion-referenced testing, *Eric/AE Digest series, EDO-TM-96-09*.

Brown, G., & Craig, M. (2003). Assessment of authentic learning. Retrieved 3/11/2004, from http://tiger.coe.missouri.edu/~vlib/glenn.michelle's.stuff/glen3mic.htm

Conyers, V., & Ritchie, D. (2001). Case study class tests: Assessment directed learning. *Journal of Nursing Education*, *40*(1), 40.

Dammers, J., Spencer, J., & Thomas, M. (2001). Using real patients in problem-based learning: Students' comments on the value of using real, as opposed to paper cases, in a problem-based learning module in general practice. *Medical Education*, *35*, 27–34.

Flachikov, N., & Goldfinch, J. (2000). Student peer assessment in high education: A meta analysis comparing peer and teacher marks. *Review of Educational Research*, *70*(3), 287–322.

Hargreaves, D. J. (1997). Student learning and assessment are inextricably linked. *European Journal of Engineering Education*, *22*(4), 401.

Harries, R., & Rutter, P. M. (2005). Cheating by pharmacy students: Perceptions, prevalence and comparisons. *Pharmacy Education*, *5*(1), 53–60.

Kerka, S. (1995). Techniques for authentic assessment, *Eric ACVE*

Maclellan, E. (2004). Authenticity in assessment tasks: A heuristic exploration of academics' perceptions. *Higher Education Research and Development*, *23*(1), 19–33.

Macpherson, K. (1999). The development of critical thinking skills in undergraduate supervisory management units: Efficacy of student peer assessment. *Assessment and Evaluation in Higher Education*, *24*(3), 273–284.

Moskal, B., & Leydens, J. (2000). Scoring rubric development: Validity and reliability. *Practical Assessment, Research and Evaluation*, *7*(10). Retrieved June 10, 2006 from http://pareonline.net/getvn.asp?v = 2007&n = 2010

Ng, H. W. W., Davies, G., Bates, I., & Avellone, M. (2003). Academic dishonesty among pharmacy students. *Pharmacy Education*, *3*(4), 261–269.

Oermann, M., Truesdell, S., & Ziolkowski, L. (2000). Stretegy to assess, develop and evaluate critical thinking. *The Journal of Continuing Education in Nursing*, *31*(4), 155.

Oliver, K. (1997). A case-based pharmacy environment: Cognitive flexibility + social constructivism, *ERIC, ED 412 924*.

Roller, L. Intrinsic and extrinsic factors in choosing pharmacy as a course of study at Monash University, 1999–2004 in Peer reviewed proceeding of the 13th International Social Pharmacy Workshop, Malta 19–23 July 2004. Pharmacy Education. 2005;*4*(3/4): 199.

Rudner, L., & Boston, C. (1994). Performance-based assessment, *Eric Review ED369389* Retrieved 1, 3, from http://eric.ed.gov/ericdocs/data/ericdocs2/content_storage_01/0000000b/80/26/40/3b.pdf

Schuwirth, L., Blackmore, D., Mom, E., Van Den Wildenberg, F., Stoffers, H., & Van Der Vleuten, C. (1999). How to write short cases for assessing problem-solving skills. *Medical Teacher*, *21*(2), 144–150.

Shankar, P. R., Subish, P., Dubey, A. K., & Mishra, P. (2006). Postgraduate students as simulated patients in communication skills learning and assessment. *Pharmacy Education*, *6*(3), 157–159.

Wiggins, G. (1990). The case for authentic assessment. *Practical Assessment, Research and Evaluation*. Retrieved 18 June 2006, 2006, from http://eric.ed.gov/ericdocs/data/ericdocs2/content_storage_01

Zariski, A. (1996). Student peer assessment in tertiary education: Promise, perils and practice. *E Law—Murdoch University Electronic Journal of Law.* Retrieved 26/10/2001, from http://carmen.murdoch.edu.au/~zariski/peer1.html