

Evaluation of a Computer-Based Bridging Course by Overseas-Qualified Pharmacists Seeking Australian Registration

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A study was undertaken to develop and evaluate computer-based bridging courses in the subjects of pharmaceutical calculations and biopharmaceutics to assist foreign pharmacists pass the Stage I exam, a part of the Australian registration requirements. The authoring package ToolBook Multimedia CBT Edition[®] running under Windows[®] was used. Each course contained a Tutorial and Test Program Thirty-two of the 39 candidates who were provided with the programs completed a questionnaire. Programs were found to be easy-very easy to install by 86 percent. High-very high ratings were given by >85 percent for the extent to which set objectives were met. More than 90 percent gave useful-very useful ratings for the modules as an exam preparation and also for the value of most program features. Test program usage was continuously collected and stored on floppy disk. Data collected from 58 candidates estimated that the average total period of use by each candidate was about 31.0 (SD ± 26.0) hours. Overall, the programs were very enthusiastically received and thought to have met their set objectives.

INTRODUCTION

The use of computer assisted instruction (CAI) in pharmacy education is growing at a rapid rate(1,2) and this includes its use as a means of continuing education(3,4). In Australia, there is a growing interest in assessing its value at both undergraduate and postgraduate levels(5-7). A major motivating factor for development is that studies have shown that CAI is of comparable effectiveness to traditional modes of teaching such as lectures(8,9). Some of the benefits to users include the ability for self-directed and self-paced learning. Even though some of the drawbacks include the need for substantial development funding and appropriate computer facilities, it has been shown that in the long term, CAI can be a cost-effective alternative to traditional teaching modes(10).

Our target group for CAI course development was foreign pharmacy graduates. In Australia, the National Office of Overseas Skills Recognition (NOOSR) oversees the endorsement of their qualifications. Ensuring that pharmacists seeking registration meet the relevant standards is a challenging task for Australian and overseas authorities. The Australian Pharmacy Examining Council Incorporated (APEC) is the equivalent of the British Adjudicating Committee(11) and the US Foreign Pharmacy Graduate Exami-

nation Commission(12) and is delegated to develop acceptable examination procedures. These countries have essentially similar protocols that consist of preliminary knowledge exams followed by practical experience, prior to registration competency exam(s). In Australia, candidates must first pass an Occupational English Test (OET) before being able to sit for the Stage I exam¹, which consists of two multiple choice question (MCQ) exams (Paper 1: pharmaceutical chemistry, pharmacology, physiology; Paper 2: pharmaceuticals, therapeutics).

Candidates passing Stage I are eligible to commence 12 months supervised practical training, followed by the Stage II exam. This consists of assessment set by the registering authority of each State which essentially addresses the attainment of a range of nationally adopted competencies(13). The problems experienced by foreign graduates (language, cultural and professional) in Australia are generally similar to those experienced in other countries(14). Many candidates are from non-English speaking countries. Therefore, registration varies greatly and so does the content of the pharmacy course originally undertaken. European and especially Middle Eastern nations have substan-

¹This exam is held twice yearly (March and September).

tially different courses and the practice of pharmacy is also markedly different to that in Australia. APEC assists candidates by providing an Information Handbook(15) setting out the requirements, lists of study references and exam requirements and also liaison with an academic advisor. Since there is no formal curriculum, APEC and NOOSR have been pro-active in exploring bridging courses² for instruction and assessment in areas of need, to make candidates aware of the expected standards of knowledge and practice.

The Department of Employment, Education, Training and Youth Affairs (DEETYA) funded the software development described in this paper. It was produced as a distance education course to assist overseas-qualified pharmacists residing within Australia to prepare for an exam which forms part of the registration requirements. The reasons for the government support included the need for efficient training to meet standards in order for candidates to begin employment in their profession. This enables Australian society to capitalize on the experience of these graduates. There is also a need for pharmacists in Australia, especially in rural locations, and it is in the interest of the profession to have these candidates meet standards in minimum time. To a lesser extent, Australia which is a multi-cultural society, could benefit by having pharmacists from a variety of ethnic backgrounds.

The aims of our study were to:

- conduct a preliminary survey of past and present candidates about a range of issues relating to preparation for the Stage I exam;
- determine potential subject areas for the development of CAI bridging courses;
- develop CAI courses in selected subject areas that included instruction and assessment reflective of the expected standard;
- conduct a survey of candidates using the CAI course to determine the degree of attainment of the set educational objectives and the usefulness of a range of program features;
- determine candidates' level of self-testing through data collection on floppy disk; and
- determine the period of CAI use needed to recover development costs.

The achievement of these objectives was important in several ways. Firstly, it was essential for current and previous candidates to express their views, problems and ideas in an anonymous way through the preliminary survey. Even though APEC had an idea of areas of weakness amongst the general group, the candidates themselves would provide a more detailed picture. The collective results could also be used by APEC for further assistance. Secondly, choosing subject areas that were requested by candidates for specific coaching would guarantee at least an initial level of interest. Thirdly, we had the educational objectives of our courses foremost in mind. Irrespective of the mode of presentation, they had to deliver quality instruction and assessment. Finally, a computer-based method of delivery was chosen that enabled the inclusion of features which were aimed at encouraging understanding as well as frequent use.

²The bridging course (without award) as described here, is one which assists participants to prepare for one or more components of their recognition requirements as previously determined by the relevant Australian assessing authority (e.g., NOOSR).

It should be noted at the outset that it was not possible to set controls for this study or undertake pre- and post-testing as a means of measuring educational impact. Use of controls was not possible because NOOSR required that all candidates have access to the program. Pretesting was not feasible due to the logistics and costs of setting up an additional test. The size of the population and its diversity are such that the reliability of the results would be questionable. Our primary impetus was not to prove that this form of CAI had direct benefits as measured by candidate assessment in exams. Hence this study sought to measure candidates' impressions and perceptions of this program and how it compared in efficiency and value to their usual study method. There was an additional quantitative component that sought to objectively measure their level of CAI use.

PROGRAM DESIGN

Computer-based modules in the areas of pharmaceutical calculations (M1) and biopharmaceutics (M2) were written using the authoring package ToolBook Multimedia CBT Edition[®] (Asymetrix Corporation), operating on a Windows[®] platform. On entering each module a Main Menu page enabled selection of either the Tutorial or Test Programs.

Software and Hardware Requirements. Microsoft Windows[®] 3.1 or higher; a Windows[®]-compatible processor (20 MHz 80386 SX processor or higher), mouse and monitor (VGA or SuperVGA running at 800 x 600 pixels resolution in small font); a 1.44 MB (3.5 inch) disk drive; a hard disk drive with approximately 12 MB of free disk space; at least 4 MB of random-access memory is required but 8 MB or more is recommended.

Program Installation. The package consisted of four installation disks and one Results Disk. The installation procedure consisted of: starting Windows[®], inserting Disk 1 into Drive A or B, selecting File from the Program Manager screen; choosing Run; typing a:\setup (or b:\setup if using the b: drive); pressing Enter and following the sequential instructions as they appear on screen.

Tutorial and Test Programs. Both modules consist of a Tutorial and Test Program. Access to either program is via the Main Menu page but the Test Program can also be accessed from any topic within the Tutorial Program. The Tutorial Program is intended to be a concise summary of the most important points and contains sufficient background instruction to competently perform a particular type of calculation or understand a concept. The modules contain didactic material covering fourteen topic areas for M1 and four for M2 (Table I). Each topic commences with an introduction and a set of objectives before proceeding to discuss the subject area. For M1, incorporated within the Tutorial Program are 101 worked examples and 108 quiz questions. M2 contains 108 quiz questions. Quiz questions contained their answers within a 'hidden window.' Further information on a topic could be found in a list of references. It was recommended that candidates proceed through the tutorial topics sequentially and complete a topic before proceeding to the Test Menu for assessment on that topic. On completion of a tutorial, the option of undertaking any number of tests is available. The Tutorial Program provides:

Table I. Title of tutorial tonics and number of test questions.

M1 (Pharmaceutical Calculations)	M2 (Biopharmaceutics)
1. Units and Conversions (20)	1. Rate-limiting Steps in Drug Absorption (23)
2. Percentages and Conversions (29)	2. Official Disintegration and Dissolution Tests (33)
3. Density and Specific Gravity (18)	3. The Passage of Drugs Across Biological Membranes (30)
4. Manipulating Pharmaceutical Formulations (15)	4. Gastro-intestinal Absorption of Drugs (40)
5. Weighing and Measuring (12)	
6. Dilution of Liquid Formulations (23)	
7. Dilution of Solid/Semi-Solid Formulations (24)	
8. Body Cavity Delivery Systems (20)	
9. Millimoles, Milliequivalents and Milliosmoles (25)	
10. Isosmotic and Isotonic Solutions (15)	
11. Buffer Solutions (12)	
12. Drug Stability (15)	
13. Molecular Manipulations (13)	
14. Posology (30)	

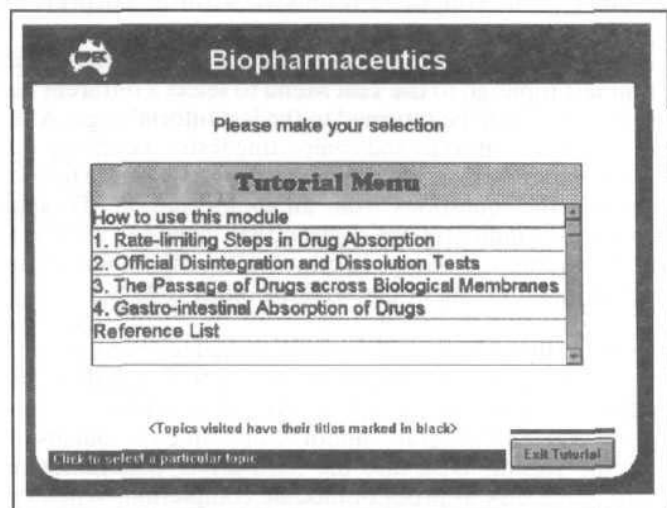


Fig. 1. Tutorial Menu page (the Test menu page is similar).

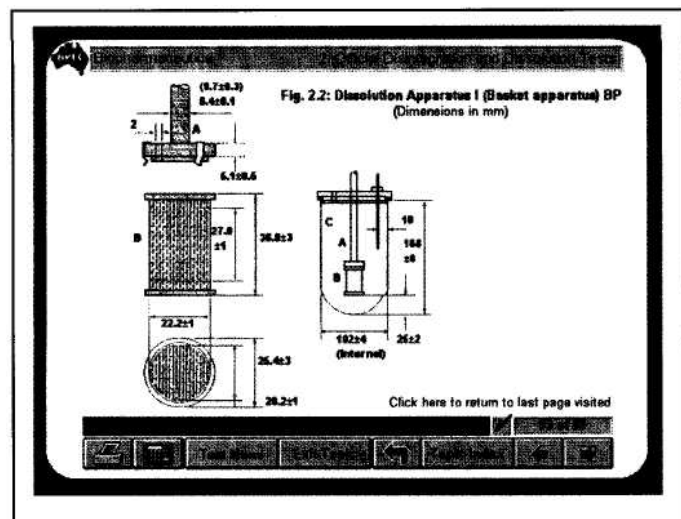


Fig. 3. Tutorial page.

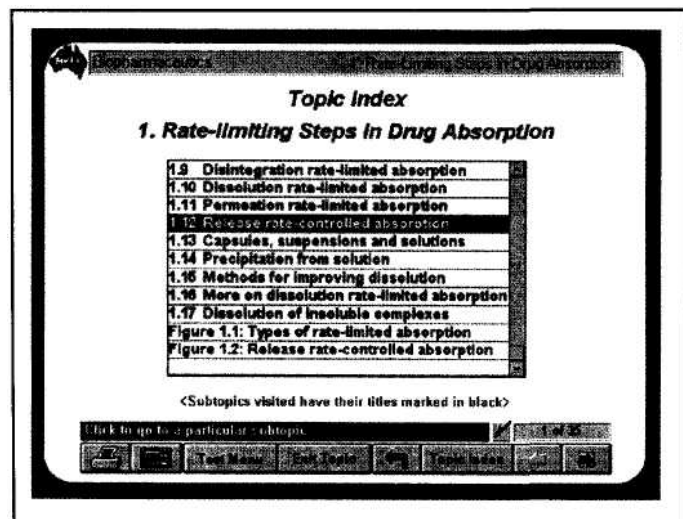


Fig. 2. Topic Index page.

The Test Programs contain MCQs related to the content of the specific tutorial. There is only one correct answer from the five answer options presented. The facility exists to receive questions randomly from all test topics. The number of questions within each topic varies, but is in the order of about twenty. The Test Programs of M1 and M2 contain 271 and 126 MCQs, respectively (Table I). The Test Programs (M1 and M2) provide:

- practice using the exam format;
- testing of tutorial content; and
- review of tutorials based on test performance.

The Tutorial Menu page (Figure 1) is the cover page to the Tutorial Program and from here a user can select their desired study topic.

On selection of a particular topic the student is transferred to the Topic Index page (Figure 2) which lists the subheadings within that topic. A user can proceed in page order (linearly) through the topic or, by clicking over a particular subheading, be immediately transferred to that section. As a means of keeping a record of sections visited, the color of the titles in the Topic Index is converted from blue to black. On leaving the module, the option exists for the settings to be saved or cancelled. On each tutorial page there is text with graphics (Figure 3) and access to a range of

- instruction in performing calculations (M1);
- thorough coverage of an area without assuming prior knowledge (M2);
- worked examples to assist understanding (M1);
- quiz questions to motivate independent thinking (M1); and
- quiz questions to assist understanding of presented material (M2).

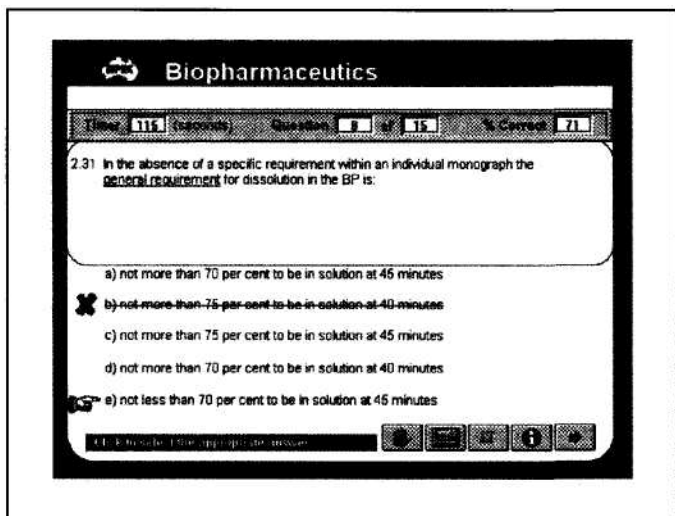


Fig. 4. Test question page.

navigational and functional options (Figure 5a). The presence of hypertext (text that performs special functions when clicked) is identified by the conversion of the mouse pointer into a hand symbol whenever the pointer rests over that text. For example, text written may function as a pop-up window of information (e.g., answer after a quiz question) or as a jump that transfers to another location within the program. Similarly the list of topics in the Tutorial Menu and Test Menu are hypertext. The function of each tool bar button located at the bottom of each page is described in the blue message bar (on-line help) whenever the mouse pointer is placed over it.

The Test Menu page is the cover page of the Test Program and is similar in design to the Tutorial Menu page. On selection of a particular topic for testing, the user is first asked whether they wish the timer to be used (120 second limit) before the first question is presented. The option for timing a test question is provided at the start of each new test. It is recommended that candidates initially proceed through a test without the timer to get a feel for the requirements of the questions. In later stages, when candidates are fine tuning their exam technique, it is thought beneficial to note their efficiency in solving a problem. If a question is not answered within the time allowed, the answer is automatically indicated on the screen and a zero mark given for that question.

Each test contains a maximum of 15 randomly selected questions containing five options and users can stop a test at any time. If the wrong option is selected, the program automatically places a cross symbol next to that option and a hand pointer next to the correct option. At this point the user can press the 'working out' button to view the full answer analysis (M1 only). The next question is received by pressing the right arrow key. Users are not permitted to review already answered questions. If a user does not answer within the allowed time, the question is marked as incorrect. The top part of the question page template includes the following: topic name and number, time remaining (in seconds) if timer option selected, number of the question in the test (e.g., 3 of 15) and the current percentage test score (Figure 4). The navigational buttons of this program are described in Figure 5b.

On completion of a test or premature exit, there is transfer to the Assessment Summary page where the final score is displayed. At this point the candidate has several

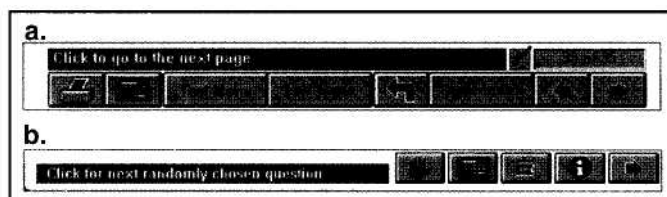


Fig. 5. Navigational features. Tutorial Program: (L-R): print page, display calculator, transfer to Test Menu, transfers from current topic to Tutorial Menu, history button (traces sequence of movements throughout program), transfers to index of current topic, previous page, next page. Position within a tutorial is indicated by the page counter and a red tick flags those pages already visited. Test Program: (L-R): stop the test (transfers to assessment page), display calculator, display additional information (this feature not implemented), display working out (M1 only), present next question.

options: print a copy of the results, view a history of previous performances (date, timer, duration, module number, topic name, total questions, percentage mark), return to the current test topic, go to the Test Menu to select a different test topic or exit and be returned to the last tutorial page. After reviewing all tutorials and completing tests on each topic, it is recommended that candidates perform composite tests by clicking the 'questions from all topics' option. To allay concerns, candidates are advised that these test scores do not form part of the Stage I exam result and that there are no penalties for failing or undertaking many tests.

Results Disk. The Test Program has the facility for recording the details of all tests undertaken onto floppy disk. The information was gathered for course development purposes. The Test Program cannot be operated without inserting the Results Disk into the hard drive. Candidates returned the disk as proof of module completion. When the disk was received, a password was issued for continued use of the Test Program without the need for a disk. The Results Disk contains the following information for each test: candidate name (optional), test date, timer on/off (if timer was off, the maximum permitted time was recorded for each question), duration of test, module number, topic number and name, number of questions, question number (e.g., 2.15 was the fifteenth question for a test on topic 2), whether each question is correct, incorrect or exited before responding) and final percentage score.

The recording of the maximum permitted time per question when the timer was off is likely to be a conservative estimate of the actual time spent given that it was suggested to candidates that they have the timer off while they were gaining experience in answering questions and not feel pressured. When they felt comfortable with the content, it was recommended that they switch it on, as a means of working under exam conditions.

Candidate Guide. A fourteen page booklet outlines the system requirements, installation procedure, description of the Tutorial and Test Programs, explanation of navigational options and general features using screen images.

METHODS

Release Period and Updates

Two versions of the program have been developed. Version 1.1 was released for the September 1996 and Ver-

sion 1.2 for the March 1997 exams. To create Version 1.2, the first version was corrected for typographical errors and the following modifications made: (i) the time allowed per question was increased from 70 to 120 seconds; and (ii) there was a Past Results Page that recorded details of a candidate's previous test performances on their hard disk drive.

Evaluation

Preliminary Survey of Candidates. A detailed questionnaire (available from the authors) was mailed to recently successful (Stage I or II) and current (first time and failed) candidates. To maintain confidentiality, the survey was mailed by APEC to 77 individuals and no reminder letter was sent. The survey sought information about: year of first registration, self-rating of written and spoken English, self-rating of understanding of pharmacy technical terms, present employment in pharmacy, access to a computer which runs Windows[®], access to a library, adequacy of information and guidance about the requirements of the Stage I exam, usefulness of various sources of information, and level of assistance needed in a range of topics within the subject areas of pharmaceutical calculations, biopharmaceutics, pharmaceutical chemistry and therapeutics. There was a desire for a moderate-high degree of assistance across all areas of pharmaceutical calculations, biopharmaceutics, chemistry disciplines and therapeutics. The two subjects chosen to merit course development for our study were pharmaceutical calculations and biopharmaceutics. (see Results)

Program Evaluation. All candidates (39) enrolled for the forthcoming exam were provided with the package (17 for September 1996 and 22 for March 1997 exams). Two months after release an eight page questionnaire was sent by mail. Areas for evaluation were: (i) Introduction: installation procedure, self-rating of computer skills, usefulness of Candidate Guide; (ii) Both modules: extent of accomplishment of set objectives for the Tutorial and Test Programs, comparison with other study methods, usefulness as a study resource and preparation for the Stage I exam; and (iii) Common program features: navigation, presentation and a range of functions. Candidate feedback to most questions was via selection from a five-point Likert scale (16). An opportunity for freehand comment about the best and worst features was also provided.

Test Program Usage. All candidates (61) enrolled for the forthcoming exams (17 for September 1996, 22 for March 1997 and 22 for September 1997) were also provided with a Results Disk which monitored Test Program usage.

RESULTS

Preliminary Survey

Sample Characteristics. There were 35 responses to the preliminary questionnaire (45.5 percent return rate). Respondents resided in: Victoria (10), New South Wales (15), Queensland (3), South Australia (2), Western Australia (4) and the Australian Capital Territory (1). Respondents were originally registered in the following periods: 1972-79 (8), 1980-90 (17) and 1991-94 (10).

Respondent Background. Respondents were asked to rate their understanding of written (w) and spoken (s) English. From 35 replies, the ratings were: average (2(w),5(s)); good

(10(w),12(s)); excellent (23(w),18(s)). Respondents' self-rating of understanding of pharmacy technical terms expressed in English were: poor (1); average (2); good (7); excellent (25). Twenty-four respondents were working in a pharmacy related field at the time of the survey. Most (22) were equally distributed between community and hospital pharmacy. The hours worked per week in pharmacy were: 15-26 hours (3); 35 hours (2); 38 hours (7); 40 hours (10); >40 hours (2). With regard to computer use, 23 people (n=34) reported they had access to a Windows[®]-capable computer either at work, university or at a hospital library. However, only 12 respondents (n=34) had home access. Thirty of the thirty-five respondents had access either to a university or hospital library containing pharmacy references.

Previous Exam Experience

From our sample, 15 (43 percent) had not passed Stage I, 16 (46 percent) had recently passed and four (11 percent) had passed both Stages I and II. The specific details were: (i) five sitting for the Stage I exam for the first time; (ii) 10 sat for the Stage I exam before but did not pass [the number of previous sittings were: once (3); twice (5); three times (1)]; (iii) 16 passed the Stage I exam recently [the number of previous sittings before passing were: once (8); twice (5); three times (1)]; and (iv) four passed the Stage II exam recently.

Evaluation of Support Provided for the Stage I Exam

APEC provides candidates with information about exam requirements and sources of assistance. They produce a guide that includes sample questions and provide a list of organizational resources and contact with a counselor, usually an academic pharmacist. In terms of receiving adequate information about the requirements of the exam about half (17) (n=35) reported that it was of adequate standard. Only eight people (n=34) felt that they had received adequate study guidance for the exam. The numbers of respondents providing a useful-very useful rating for the following sources of information were (n=34): APEC Information Handbook (15); Pharmaceutical Society of Australia (7) [14 did not use]; Registering authority (3) [17 did not use]; APEC Counselor (13) [9 did not use]. Various reference books recommended for Australian pharmacy undergraduates were found beneficial for exam preparation. Also included as beneficial were study guides and reviews produced by NABLEX. When candidates were asked what could be done (or could have been done) to assist them in exam preparation, feedback included: a more detailed syllabus; more sample questions of the standard expected; a structured study program covering material relevant for the exam; scenarios and case studies with explanations; arrangement of tutorial sessions to revise information; study modules with further references; lectures in certain subjects (e.g., chemistry) that cannot be learned in a work environment but must be known for the exam, and previous exam papers. Some respondents stated that sample questions in the APEC Information Handbook were too easy and insufficient in number.

Desired Level of Subject Assistance

The number of respondents who desired a high-very high level of assistance for the following subject areas were: pharmaceutical calculations (20; n=33); biopharmaceutics (16; n=32); organic chemistry (14; n=29); stereochemistry

Table II. Number of candidates providing a 'high-very high' rating for achieving objectives⁸

	Number of candidates (percent; n)	
	Module 1	Module 2
Tutorial Program		
• Provide broad instruction in performing calculations	28 (87.5; 32)	#
• Provide thorough coverage of an area without assuming significant prior knowledge	#	28 (87.5; 32)
• Provide worked examples to assist understanding	29 (90.6; 32)	#
• Provide quiz questions to motivate independent thinking	31 (96.9; 32)	#
• Provide quiz questions to assist understanding of the material presented	#	30 (93.8; 32)
Test Program		
• Encourage testing of tutorial content	28 (90.3; 31)	27 (90.0; 30)
• Provide practice using exam format	27 (90.0; 30)	28 (96.6; 29)
• Encourage tutorial review based on test performance	26 (83.9; 31)	26 (86.7; 30)

Not applicable.

^aThe assessment scale covered a range including: 'very low,' 'low,' 'moderate,' 'high,' and 'very high.'

(12; n=25); physical chemistry (6; n=19); analytical chemistry (9; n=26); biochemistry (7; n=24); medicinal chemistry (13; n=25); and therapeutics (16; n=26).

SOFTWARE EVALUATION

Sample Characteristics

Thirty-two of the 39 candidates (82.1 percent) who were provided with modules returned a questionnaire. The number of responses and corresponding return rate for the September 1996 and March 1997 groups were 15 (88.2 percent) and 17 (77.3 percent), respectively. Candidates in this sample were registered in the following periods: 1966-76 (5), 1977-86 (13), 1987-96 (13) and unstated (1). The location of program use was: home (23); computer center (1); library (1) and 'other' (7). Of the twenty-one candidates who self-installed the program, eighteen found the procedure easy-very easy. Respondents personally rated their computer skills as: low-very low (3), moderate (20), high-very high (8) and unstated (1). Only four candidates reported 'technical' problems and these related to improper installation and mouse clicking. The Candidate Guide provided with the software was found to be useful-very useful by 24 candidates.

Achieving Objectives

Candidates were asked to rate the value of each module in achieving its objectives (Table II). For the Tutorial Program objectives, the following proportion of respondents provided a high-very high rating: 87.5-96.9 percent (28-31) for M1 and 87.5-93.8 percent (28-30) for M2. For the Test Program objectives, the following proportion of respondents provided a high-very high rating: 83.9-90.3 percent (26-28) for M1 and 86.7-96.6 percent (26-28) for M2.

Comparison of CAI with Other Study Methods

Students were asked to compare the module with using other study methods (e.g., books) (Table III). Between 90.6-96.9 percent (29-31) and 93.5-100.0 percent (29-32) of respondents provided a better-much better rating, in favor of the CAI program, for M1 and M2, respectively. The areas compared were: enthusiasm to study a particular topic; ability to understand the content and worked examples (M1 only); ability to test knowledge; and as an overall study source.

Tutorial and Test Program Features

Students were asked to rate the quality of a range of module features such as navigation, presentation and help

Table III. Number of candidates providing a 'better-much better' rating, in favour of CAI, compared to other study methods^a

	Number of candidates (percent; n)	
	Module 1	Module 2
Enthusiasm to read particular topic	30 (93.8; 32)	30 (93.8; 32)
Understanding of the material	30 (93.8; 32)	29 (93.5; 31)
Understanding of worked examples	29 (90.6; 32)	#
Testing one's knowledge	31 (96.9; 32)	32 (100.0; 32)
As an overall study source	31 (96.9; 32)	30 (93.8; 32)

Not applicable.

^aThe assessment scale covered a range including: 'much worse,' 'worse,' 'no difference,' 'better,' and 'much better.'

functions. The proportion providing an easy-very easy rating for the navigational aspects of the Tutorial and Test Programs were: 93.8 percent (30 of 32 respondents) and 93.5 percent (29 of 31 respondents), respectively. For the presentation quality (including layout, design and graphics) of the Tutorial and Test Programs, a high-very high rating was given by 90.6 percent (29 of 32 respondents) and 93.5 percent (29 of 31 respondents), respectively.

In order to make both programs attractive for use, a range of features was built in. Generally, for the Tutorial Program 73.3-96.9 percent (22-31) of candidates rated its features as useful-very useful. The only exception was the calculator function for which a lower proportion of candidates (40.6 percent) gave the same rating (Table IV). For the Test Program 80.0-100.0 percent (24-31) gave a useful-very useful rating for its features. Again, the exception was the calculator function (45.2 percent) (Table V).

Educational Value

The opinion of candidates was sought about the application of the CAI package as a study tool (Table VI). Most candidates (90.3-100.0 percent) thought both modules were useful-very useful in terms of improving overall subject knowledge and as a preparation for the APEC exam. The level of language expression was found appropriate by 71.0-75.0 percent of respondents. Since English was a second language for most candidates, it was important that text was easy to read and that technical terms be well defined. Both modules were seen as a complementary source to other means of study by

Table IV. The number of candidates providing a 'useful-very useful' rating for a range of Tutorial Program features (present in both modules)^a

	Number of candidates (percent)		
	'useless-little use'	'neutral'	'high-very high'
On-line help (n=32)	0 (0.0)	5 (15.6)	27 (84.4)
Print a page (n=32)	2 (6.3)	5 (15.6)	25 (78.1)
Display a calculator (n=32)	8 (25.0)	11 (34.4)	13 (40.6)
Go to Test Program at any time (n=32)	0 (0.0)	5 (15.6)	27 (84.4)
Exit Tutorial Topic at any time (n=32)	0 (0.0)	2 (6.3)	30 (93.7)
History function (n=30)	2 (6.7)	6 (20.0)	22 (73.3)
Go to Topic Index at any time (n=32)	0 (0.0)	2 (6.3)	30 (93.7)
Page number (n=32)	0 (0.0)	1 (3.1)	31 (96.9)
Marker for pages visited (n=31)	0 (0.0)	3 (9.7)	28 (90.3)

^aThe assessment scale covered a range including: 'useless,' 'little use,' 'neutral,' 'useful' and 'very useful.'

Table V. The number of candidates providing a 'useful-very useful' rating for a range of Test Program features (present in both modules)^a

	Number of candidates (percent)		
	'useless-little use'	'neutral'	'high-very high'
Option to time a test (n=30)	2 (6.7)	4 (13.3)	24 (80.0)
Continuous scoring (n=31)	1 (3.2)	1 (3.2)	29 (93.5)
Stop test at any time (n=31)	0 (0.0)	2 (6.5)	29 (93.5)
Display a calculator (n=31)	9 (29.0)	8 (25.8)	4 (45.2)
View the working of a question (M1) (n=31)	0 (0.0)	1 (3.2)	30 (96.8)
Reasonable number of questions for each topic (n=30)	0 (0.0)	0 (0.0)	30 (100.0)
Random selection of questions from each topic (n=31)	0 (0.0)	0 (0.0)	31 (100.0)
Random selection of questions from all topics (n=31)	0 (0.0)	1 (3.2)	30 (96.8)
A large bank of questions (n=31)	0 (0.0)	0 (0.0)	31 (100.0)
A score and comment at the end of each test (n=30)	1 (3.3)	2 (6.7)	27 (90.0)
View previous test results summary (VI.2 only) (n=10)	0 (0.0)	1 (10.0)	9 (90.0)

^aThe assessment scale covered a range including: 'useless,' 'little use,' 'neutral,' 'useful' and 'very useful.'

Table VI. Number of candidates rating the value of the package as a study tool

	Number of candidates (percent; n)	
	Module 1	Module 2
Improving overall subject knowledge ^a 'useful-very useful'	32 (100.0; 32)	29 (90.6; 32)
Level of language expression used ^b 'appropriate' 'difficult-very difficult'	22 (71.0; 31) 1 (3.2; 31)	24 (75.0; 32) 3 (9.4; 32)
As a preparation for the Stage I exam ^a 'useful-very useful'	28 (90.3; 31)	29 (93.5; 31)
Best description of overall use of module ^c sole means of study complementary source to other means	10 (33.3; 30) 20 (66.7; 30)	8 (26.7; 30) 22 (73.3; 30)

Assessment Scales: ^aUseless, little use, neutral, useful, very useful.

^bSimplistic, a bit simple, appropriate, difficult, very difficult. ^cTwo options (sole means of study or complementary source).

most candidates (66.7-73.3 percent) rather than as a sole means. These modules were intended to be stand-alone units of instruction and assessment and any candidate successfully completing them would certainly have been able to cope with

questions in the Stage I exam. The fact that respondents did not view them in this fashion may suggest that they feel the need for exposure to other sources of instruction as a means of boosting confidence in the material presented and in their own abilities to comprehend it.

General Comments

Freehand comment was invited about candidates' perceptions of the best and worst features of the modules. For the calculations module the best features mentioned were the presence of worked examples, the large selection of topics and ease of use. The worst features were some calculation errors in both the Tutorial and Test Programs and the short 70 second/test question time limit option. This limit was later increased to 120 seconds for Version 1.2 of the program. For the biopharmaceutics module the best features included the clarity of explanations, presence of quiz questions and conciseness. The worst features centered mainly on the lack of explanation for incorrect answer selections in the Test Program and some typographical mistakes. Thirty students (93.8 percent; n=32) indicated that they would like further modules to be developed. Frequently suggested topics were pharmaceutical and medicinal chemistry, pharmacology, drug interactions and therapeutics.

TEST PROGRAM USAGE

Fifty-eight of the 61 candidates (95.1 percent) returned a Results Disk for analysis. The number of disks and corre-

sponding return rate for the September 1996, March 1997 and September 1997 groups were 17 (100.0 percent), 21 (95.5 percent) and 20 (90.9 percent), respectively. The September 1997 group were also included to increase the sample size for calculating the best estimate of the usage level. Collectively, 2,865 tests were undertaken (M1: 1,713; M2: 1,152) and 36,821 questions were attempted (M1: 20,900; M2: 15,921). Only attempted questions were counted and if a user 'exited' a question without answering, that question was not tallied. The timer option was selected for 24.3 percent of all tests in M1 and 55.7 percent of all tests in M2. The period of testing with timer 'on' was: M1 (70.7 hours) and M2 (47.7 hours). The period of testing with timer 'off' (maximum allowable time recorded) was: M1 (412.4 hours) and M2 (185.8 hours). A total of 716.6 hours was spent by the 58 candidates, averaging 12.4 (SD \pm 10.4) hours (Range 0.2-46.7 hours) per candidate. The average period spent answering a question (using the timer) was significantly higher ($P < 0.001$; two-tail Student's *t*-test) for M1 tests (53.2 seconds) compared to M2 tests (19.1 seconds). This was not surprising since M1 required actual solving of calculations, whilst M2 drew upon interpretation of facts.

COST ANALYSIS

Within this group of 58 candidates, we determined that on average 12.4 (SD \pm 10.4) hours (Range 0.2-46.7 hours) per candidate was spent undertaking tests in both modules. If we conservatively assume that about 1.5 times that period of time was spent on reviewing the tutorial content, then on average 31.0 (SD \pm 26.0) hours was used for total study. The question is often asked as to whether CAI is cost effective. It cost about \$50,000 (AUD) to develop these modules. Even though this is a large upfront outlay, what needs to be balanced is the annual cost of face-to-face teaching of candidates with the period of CAI use required to recover costs.

The costs for say 30 hours of lecture presentation should include the preparation of core materials. These materials would be used by instructors, in each of six States, twice yearly around Australia. The 18 tutorials in the modules took about 5 hours each to produce (90 hours) and the 15 questions (approximate) per tutorial took 3 hours each (54 hours). Assuming the cost to pay an academic is \$40 (AUD)/hour then the total cost for core material development (144 hours) would be \$5,760. When presenting this material an instructor would need about an hour of didactic presentation time followed by an hour for student assessment. For the 18 topics, this equals to 36 hours of instruction/assessment. Since some topics, especially on density and percentages are relatively easy, a total time of 30 hours would be reasonable. The cost for each instructor to be present for 30 hours (at \$40 per hour) to prepare a group of candidates for one exam, would be \$1,200.

The cost of preparing two groups of candidates each year, in each of six States, would be: \$14,400. It would therefore take three years (six Stage I exam preparations) ($\$14,400 \times 3 + \$5,760 = \$48,960$) to recover the development costs of these modules. Given the nature of the content of these modules, an estimated shelf-life for use would exceed five years and hence several years of use without cost are possible.

DISCUSSION

Meeting the educational needs of a heterogeneous population of overseas-qualified pharmacists seeking Australian

registration is a challenging task. A range of factors previously alluded to can contribute to the difficulties in preparing for the registration exam. It is not surprising then that sometimes more than 30 percent of presenting candidates fail the Stage I exam on their first attempt.

The preliminary survey enabled us to document the perceived inadequacies of the present system. There was a desire for a moderate-high degree of assistance across all subject areas. Candidates requested more sample questions of the standard expected, case studies with explanations, tutorials for revision, study modules with further references, structured programs covering material relevant to the exam and formal lectures in particular areas such as chemistry.

The implementation of computers and CAI in many areas of education is gaining momentum. The use of authoring tools such as Toolbook[®] has enabled the development of programs with a high standard of presentation. Even though this authoring program is simple to operate it does require the skills of a multimedia developer to efficiently create packages that have high sophistication. The content of the program also plays a pivotal role in the acceptance and success of CAI and hence careful thought needs to be given to the development of materials that meet specific educational objectives. To achieve these goals successfully, a team approach is the best option. Thorough checking of software functions and careful screening of content accuracy takes time but must be systematically undertaken prior to the package being released.

Overall, the modules were reported to be highly beneficial and used frequently. Since this was a distance education package for candidates residing all over Australia, it was vital that the instructions for use were clear. The relatively simple installation procedure enabled most candidates to feel comfortable self-installing the program. The description of program features in the Candidate Guide was important in assisting the candidate to visualize what the whole package was about.

The educational objectives of both the Tutorial and Test Programs were rated highly by the majority of respondents. It is important to note that about sixty percent of the sample had attained their registration overseas prior to 1987. Therefore quality instruction and assessment were perceived to have been delivered by this mode of teaching by a group of pharmacists with varying experience. It was also evident that when respondents were asked to compare the modules to other study methods, such as the use of books, they consistently rated the modules better in terms of enthusiasm to read a particular topic, understanding the material, understanding worked examples, testing one's knowledge and as an overall study source.

The majority viewed the modules as a very useful preparation for the Stage I exam, however about two thirds regarded their use as complementary rather than as a sole source of study. All features of the Tutorial and Test Programs were positively viewed, except for the pop-up calculator. Presumably most candidates found it more convenient to use their own calculators rather than do calculations on the screen. We believe that the wide range of features created interest and flexibility in the use of the modules. Therefore a combination of good presentation and navigational design as well as educational content may have been key factors behind their popularity.

CAI is most efficiently used in teaching situations that require multiple presentations of the same lecture content (e.g., solving pharmaceutical calculations). A well designed

and comprehensive package can suit a wide audience through the incorporation of a large body of material that could be selected via hyperlinks or pop-up windows depending on individual requirements. We were encouraged to find that about 94 percent of respondents wished for more modules to be developed particularly in the areas of chemistry, pharmacology, drug interactions and therapeutics. One of the benefits of the existing modules is that since the current template designs for both the Tutorial and Test programs were found suitable, they could be used again to develop additional modules in other subject areas within a shorter time frame.

CONCLUSIONS

The candidates' opinions were highly favorable in their acceptance of the modules. We have shown that the use of CAI can allow educators to develop programs that can enhance or replace didactic lectures. This is most efficiently applied in teaching situations that require multiple presentation of the same didactic material. The programs developed were thought to have met their set objectives, were perceived to be very user friendly, functional and well presented. An updated version is now planned which will increase the size of the question database.

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