Computer-Assisted Interactive Tutorials on Clinical Problem Solving in Family Medicine

***Cynthia Chan*[1], *Yuk Tsan Wun*[1], *Keith Chan*[2]**

[1] *Chinese University of Hong Kong,* [2] *City University of Hong Kong*

Abstract

The aims of the project are to train medical students in problem-solving and clinical decision-making through development and utilisation of a software package for computer-assisted interactive tutorials (CAIT). Written with Visual Basic, the CAIT has a browser, an editor and a 'house-keeper'. It utilises multi-media technology and simulates problem solving in family practice by placing limits on the duration of a 'consultation' and the number of choices in each section of information gathering. Students have to make decisions and justify their choices by committing to a multi-dimension probability diagnosis at each step of the process. Thirty-nine percent (n=60) of the class of fourth year medical students was given access to the CAIT. Students' summative assessment results were compared. They also completed a questionnaire to evaluate the CAIT.

The CAIT has the advantage of allowing students to work through a number of patient problems safely on their own and then acting as a springboard for group discussion. Since the number of cases produced was small, there was no statistically significant difference in the summative assessment between the users and non-users. The CAIT was, however, found by the majority to be a helpful and interesting way to develop problem-solving skills, and was considered to be user-friendly. It is recommended that further cases should be written to expand the 'patient pool' of the CAIT. Students' problem-solving can be monitored for progress, to see if maturation has occurred following the teaching programme.

Background and Initial Reflection

Medical students at The Chinese University of Hong Kong spend their first two years learning the basic pre-clinical medical sciences (anatomy, biochemistry, physiology, pharmacology, behavioural and social science). In the third year, in addition to studying pathology, they are taught the basic clinical skills and the fundamental knowledge of medicine and surgery. In the fourth year, they rotate through four clinical departments: Obstetrics and Gynaecology, Paediatrics, Psychiatry, and Community and Family Medicine. In the transition from pre-clinical to clinical years, in addition to further theoretical studies, students face the problem of how to apply theory and facts to individual patient care. The transition is especially difficult in their rotation to the Family Medicine module for the following reasons:

- The nature of the discipline of Family Medicine

Family Medicine is a discipline of breadth. The family doctor provides comprehensive and continuing care to patients of all age groups with one or more of a large number of health problems. S/he must of necessity have an indepth knowledge of medicine as well as of social and behavioural science at different life stages. Patients in primary care usually present at the initial stage to the family doctor, often with disorganised history and with problems which are

vague and undifferentiated and even unnoticed to the unwary physician. Good problem-solving skills are just as important, therefore, as sound medical knowledge.

- The Family Medicine curriculum

Sources of factual knowledge are abundant, either in printed form (books, journals) or electronic form (CD-ROMs, World Wide Web). Students, especially those who are motivated, usually do not encounter difficulties in obtaining factual knowledge after minimal guidance. However, problem-solving skills are difficult to learn. Repeated exposure to problems and on-site supervision where they can receive immediate feedback are essential for the development of problem-solving skills. Small-group or even individual tutorials are most suitable for teaching and acquiring problem-solving skills. The Family Medicine unit has been teaching problem-solving skills using small-group tutorials and role-plays with these sessions having been well received by students. Such tutorials demand heavy resources in terms of staff and curriculum time. With the doubling of student numbers in the Faculty of Medicine in recent years, these demands have become extravagant luxuries in the existing over-packed curriculum and for the over-loaded staff. With limitations in manpower, either the group size must increase or some other manpower-efficient teaching methods which provide the students with just as much experiential learning and individual feedback must be devised. The computer assisted interactive tutorial (CAIT) serves such a purpose because it can be made accessible to students and provides interaction and individual feedback.

- Patients with multiple problems and multiple approaches to the same problem(s)

One of the many characteristics of patient problems in Family Medicine is the plurality of multi-faceted problems: multiple physical, psychological and social problems that are all dynamically inter-related. Thus, although faced with the same patient, different doctors may take different approaches to solve the same problem(s). Clinical problem-solving is not a didactic, simplistic, doctor-oriented approach that utilises only reductionist reasoning, but also takes on the systems and patient-centred approaches that allow for variability and individual adaptability. Students who are used to a mechanical 'fill-in-the-form cook-book recipe' approach, often find it difficult to cope with the multiplicity of problems and have to be guided.

- Limited accessibility of suitable patients in community-based care

Family Medicine teaching in Hong Kong is conducted mainly in outpatient clinics. In these community-based clinics, patients are more autonomous and may not be willing to spare the time during their busy daily schedules to be clerked by students, especially when they are paying for the visit. There is unpredictable availability of suitable patients with a particular problem. A student who wishes to practice tackling a certain problem may not be able to meet a patient with that problem at the time. Physician teachers in community practice are more concerned at the possibility of the student making a mistake and upsetting the patient. The provision of structured simulated patients for problem-solving will overcome these obstacles. The advantage of simulation is the ability to structure defined problems with varying degrees of complexity. It is particularly useful since it avoids the untoward and undesirable mistakes which may be made when students are dealing with actual patients. With computer simulations, students can have access to the cases at a convenient time and when they are motivated to learn. Multiple students may also have access to the same programme at the same time.

Aims

The aims of the project, therefore, are to train medical students in problem-solving and clinical decision-making through development and utilisation of multimedia computer-assisted interactive tutorials.

Computer Assisted Interactive Problem Solving

Computer-assisted patient simulation has been used for a long time both for training and examination (Shannon, 1990; Stanley, & Stephens, 1991; Myers, & Dorsey, 1994; Cobbs, Pincetl, Silverman, Liao, & Motta, 1994). Multi-media technology makes simulation closer to real life (Loke, & Lun, 1998; McGee, Neill, Goldman, & Casey, 1998; O'Connor, McGraw, Killen, & Reich, 1998). Proven structure principles are that the simulation should be in a problem-oriented approach with the separation of educational mode and scoring mode (Klar, & Bayer, 1990). Other important quality criteria are software design and user interface (Klar, & Bayer, 1990). A wide range of simulations, representing diverse content areas and utilising a variety of implementation strategies, are either being developed or in their implementation stages. These new systems promise to make broad-based training experiences available for students at all levels, without the risks and ethical concerns typically associated with using human subjects (Hoffman, & Vu, 1997). Medical students can acquire proficiency, and gain confidence in the ability to perform a wide variety of techniques. The CAIT is a unique tool which can enhance clinical problem-solving skills, although it obviously cannot replace bedside teaching. Hoffman, & Vu (p.1076) state that:

> These simulated encounters, in combination with existing opportunities to work with real patients, could increase the depth and breadth of learners' exposure to medical problems, ensure uniformity of training experiences, and enhance the acquisition of clinical skills.

Video Records of Local Patient Encounters in Cantonese

Video records of authentic physician-patient interactions can be used to bring actual patients into the learning environment at the learner's own time. The other advantages are that facial expression, tone of voice and other non-verbal forms of communication can be reviewed. Students in Hong Kong are taught in English but have to communicate with patients in Chinese. Videotapes of local patient encounters can familiarise them with the use of Chinese terms, and help them to appreciate the subtleties of Chinese language and the Cantonese dialect, and the choice of words in patient communication. The use of materials which are developed locally is important because there are many contextual issues in Family Medicine that pertain to the local Chinese concepts of health and illness: drug use, patient-doctor relationships, illness behaviour, and family and social factors which are quite different from those experienced in western societies. Interactions between teacher and student without the physical presence of the teacher are not possible with the conventional videotapes. Computer-assisted interactive learning is a solution if video records are to be used as a teaching medium.

Plan

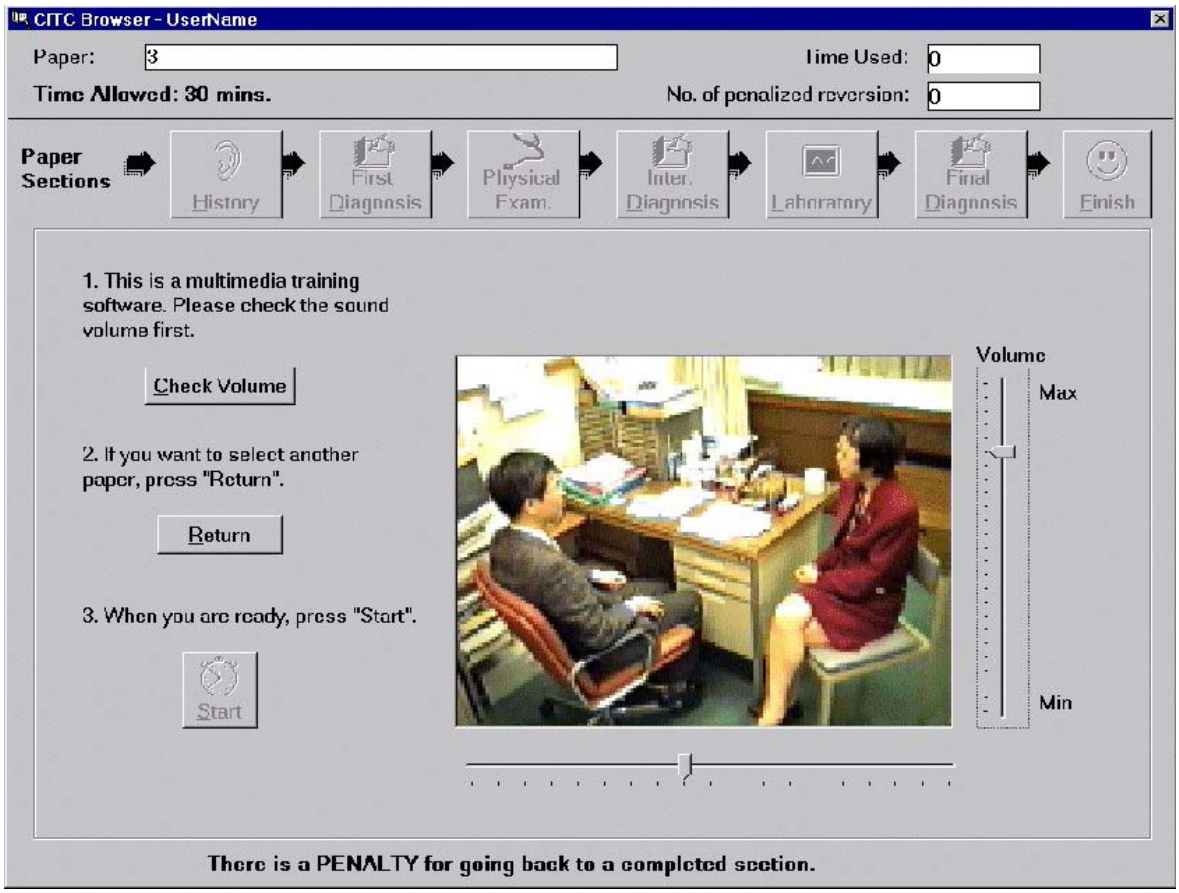
Computer-assisted interactive tutorials (CAIT) with videotape excerpts of physician-patient encounters were designed to address the above problems. The objective of the CAIT is to train quality problem-solving thinking and diagnostic strategies required in Family Practice. A briefing and a debriefing session was held before and after students worked with the CAIT.

CAIT Components

The CAIT consists of three separate parts: a browser, an editor, and a utility-tool. The browser presents the tutorial and teaching materials to the student. The editor is the author-ware for designing new tutorials: setting questions, answers (in text or multi-media format), marking schemes, and reference materials. The author-ware is simple to use so that local audiovisual clips of patient interviews can easily be added. The utility consists of a report-generator and a system-maintenance to define users. The whole software is written with Visual Basic™.

After an introductory video of a patient presenting with the main complaint (Figure 1), the student is expected to take the conventional approach of history taking, physical examination and laboratory investigation. Diagnoses are required after each section. The time required to finish one simulation can be set with the author-ware.

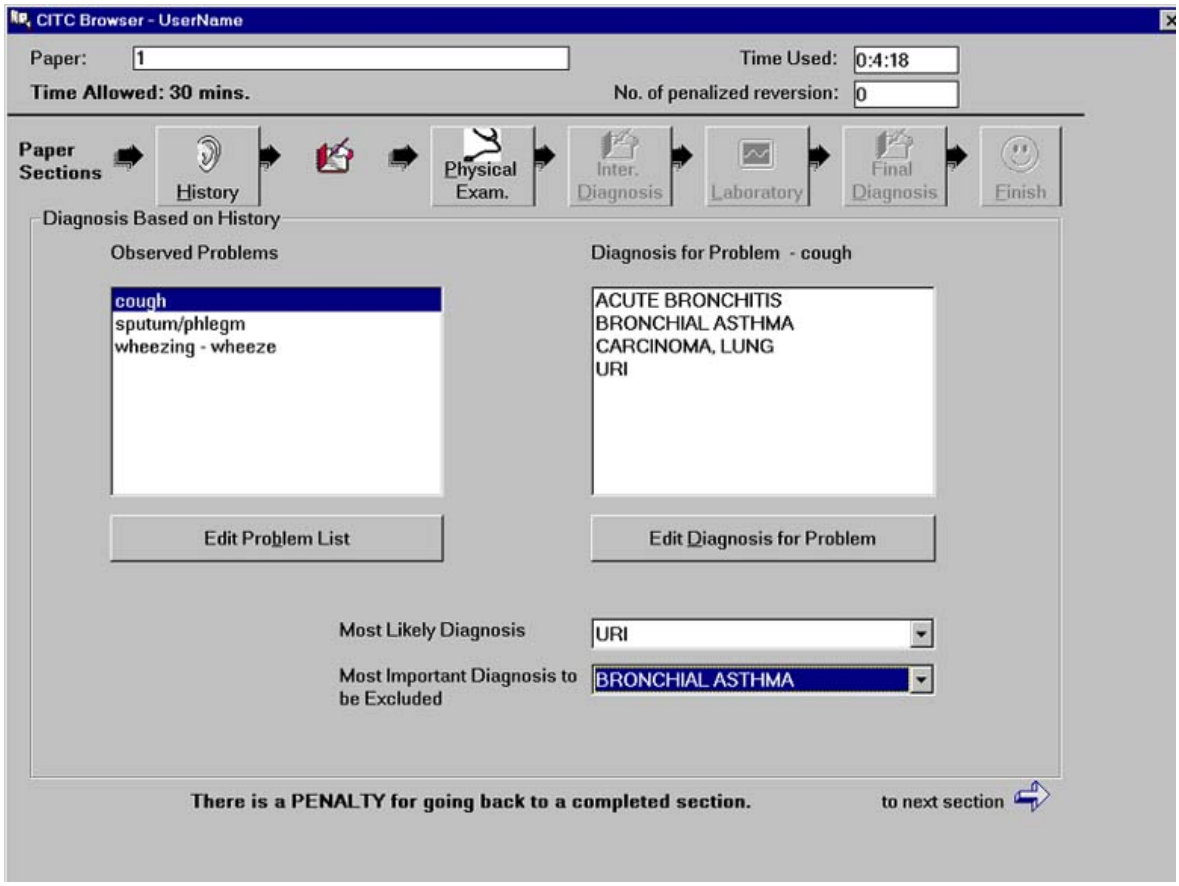
Figure 1: Screen for navigation of CAIT



When taking the history, a student must key in keywords e.g. duration of symptom, fever, to learn more about the main complaint and try to identify its cause. The answer to a particular item is presented in text or video formats. The maximum number of questions that can be asked is pre-set. There is a 'suggested number of questions' which can give adequate information for a diagnosis. By limiting the amount of questions to be asked, the student is forced to be selective and choose questions that will give a better yield in terms of problem-solving.

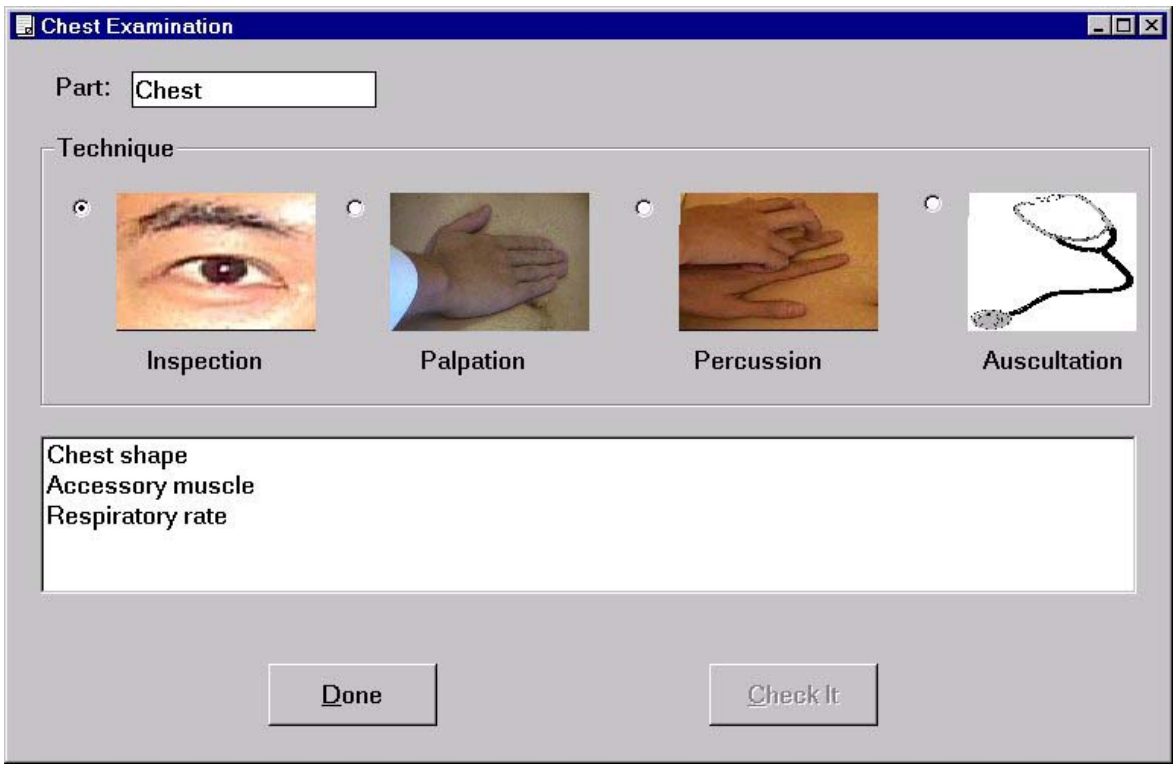
After the history, the student must proceed to the first section of diagnosis. Here the student takes each symptom thought to be of diagnostic value to draw up a problem list (Figure 2). For example, cough for one month with subjective wheeze in a non-smoking, middle-aged housewife with family history of allergy, may lead to the diagnoses of bronchial asthma, atypical pneumonia and pulmonary tuberculosis. At this stage, the student is required to make a list of differential diagnoses, to name the single most likely diagnosis and the most important diagnosis to be excluded.

Figure 2: Screen of problem list and differential diagnoses list



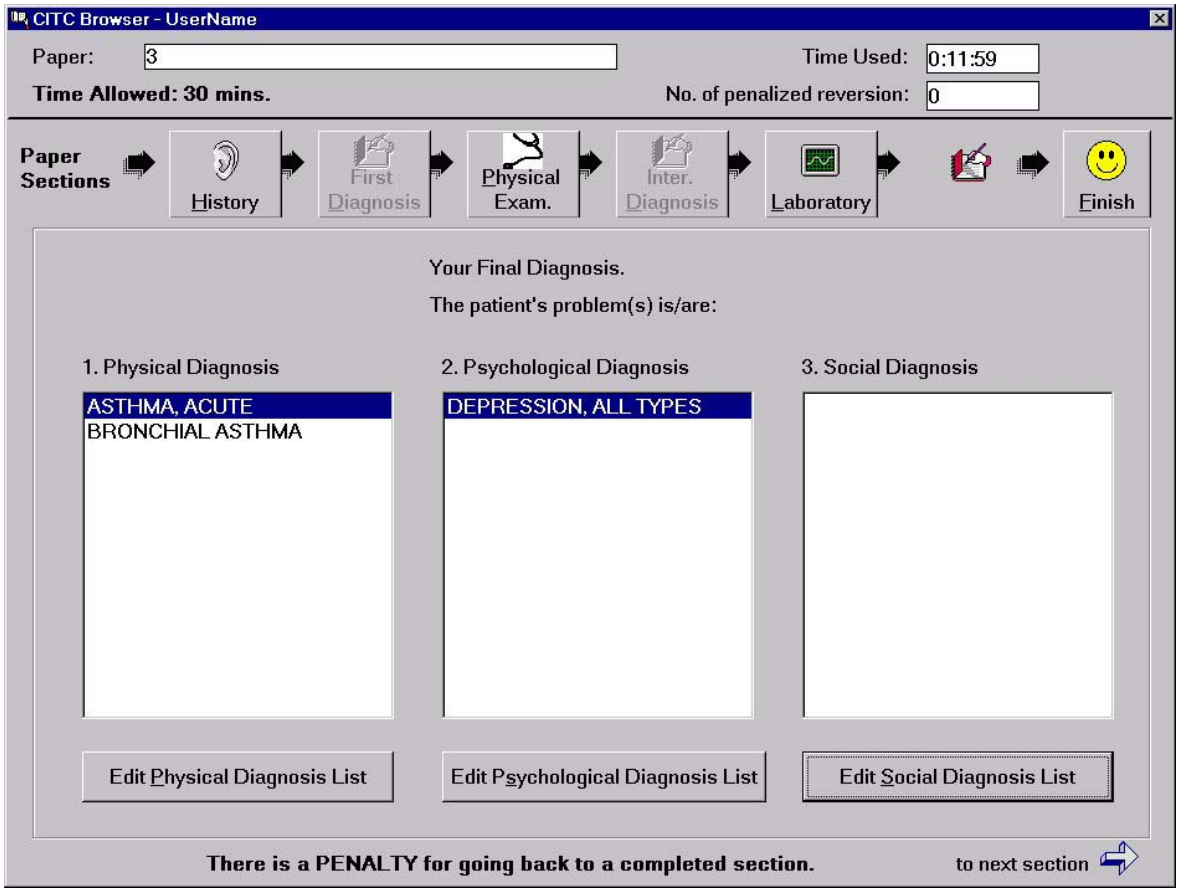
The student can then perform a 'physical examination' by first selecting an area on the human body and then performing the 'IPPA' (inspection, palpation, percussion and auscultation) (Figure 3). The results of the examination are given either in text, sound or images. After the examination, the student has to interpret the meaning of the findings and revise the problem list and differential diagnoses as in the history section after the examination.

Figure 3: The IPPA screen for chest examination



The same process applies for the laboratory investigation section, which may be omitted if investigations are deemed unnecessary. For the final diagnosis, students are encouraged to have a holistic outlook and think about physical, psychological and social diagnoses (Figure 4), although not all three are necessarily present at the same time in an individual 'case'. For example, the patient may have a final diagnosis of atypical pneumonia which was poorly managed because the patient was going from doctor to doctor.

Figure 4: Screen of final diagnosis



At the end, the student may read a brief report of his/her performance and reference educational materials on the patient's problems. The performance report shows the choices of each section and the scores made for each choice, together with the overall score obtained by the student in that session.

Action

Use of the CAIT

The software of the CAIT was completed in the first phase and the initial test case was installed in the departmental computer network server. It was pilot tested on module one and two students in 1998-99. During the next few months, further refinement was made and a total of four cases were produced and made available to students by the 1999-2000 academic year.

Though some computer-assisted patient simulations are designed for self-directed learning, we did not use the CAIT to replace, but to be adjunct to, small group tutorials. Our objective is to train students to develop clinical reasoning ability. A student's strategy (how and why the choices are made) is more important than the content (what choices are made). Discussion of the mistakes and the strategy is important. We used the CAIT as the introduction for small group discussions. Time slots were assigned in the teaching curriculum to allow students to work on the CAIT under the supervision of the investigators. By working on the CAIT, each student had to commit himself by making decisions at each step of the problem-solving process, rather than 'hide'

behind the crowd in a tutorial. After students had worked on the CAIT, a debriefing session was held to discuss their choices, findings, interpretation and hypotheses.

Method to Ensure Appropriate Evaluation of CAIT

Students undertaking the Family Medicine subject rotate through four modules at the four clinical departments mentioned above. They come to our department at different stages of maturation, i.e., students in module 4 would have more experience and knowledge than students in module 3, while students in module 3 will have more experience than those in module 2, and so on. One therefore, cannot compare directly students from different modules. To overcome this maturation bias, half of the students from each module were randomly assigned to group A and the other half to group B. Group A had one regular session of tutor-led small group tutorials with diagnostic interview role plays and case discussions, while group B had one session of CAIT with a debriefing session. The same tutor led both groups A and B in each module.

In order to avoid cross-contamination between groups, only students in group B were allowed access to CAIT at scheduled times, until the evaluation period was over. Summative assessment of problem-solving was included in our regular departmental objective structured clinical examination (OSCE) at the end of the module. A number of stations were used to test the performance of the students' clinical problem-solving skills.

Reflection and Evaluation

A. Evaluation of Students' Acceptance of CAIT

Of the 60 students who attempted the CAIT, 56 (93%) returned the feedback questionnaire. The responses were on a 5-point Likert scale from 'strongly disagree', 'disagree', 'neutral' to 'agree' and 'strongly agree'. Sixty percent strongly agreed and 40% agreed with the statement that the CAIT was an interesting way to learn. Twenty-two percent and 75% respectively strongly agreed and agreed that the overall education value of the CAIT was good (Figure 5).

Figure 5: Interest and educational value of CAIT

	CAIT is an interesting way to learn	**Overall educational value is good**
	% (n = 50)	**% (n = 55)**
Strongly Disagree	0	0
Disagree	0	1.8
Neutral	0	1.8
Agree	40	74.5
Strongly Agree	60	21.8

Three-quarters felt that CAIT was helpful for learning about taking a relevant history, while about half thought that CAIT was helpful for learning about making a problem list, selecting the relevant physical examination, selecting the appropriate investigation and thinking through the probabilities of various differential diagnoses. Only three students were neutral about attempting another case in future and only four were neutral about recommending CAIT to their classmates (Figure 6).

Figure 6: Student opinions about recommending CAIT and its worthiness of using again

	Recommend to my classmates	**Attempt another case in future**	**Can try out other CAIT cases without the guidance of a tutor**
	% (n = 56	**% (n = 56)**	**% (n = 56)**
Strongly Disagree	0	0	1.8
Disagree	0	0	5.5
Neutral	7.1	5.4	9.1
Agree	57.1	53.6	52.7
Strongly Agree	35.7	41.1	30.9

As for its user-friendliness, one strongly disagreed, 28.6% disagreed, 21% were neutral, 39% agreed and only 9% strongly agreed with the statement that they had little difficulty with the technical aspect of the programme (Figure 7). Only half agreed or strongly agreed that the procedure was self-explanatory, 39% were neutral and four disagreed. These four also felt that the programme was difficult to follow. However, on the second attempt, they had fewer technical problems. The proportions agreeing with the statement that they had fewer technical problems the second time were 3: 5.6% disagreed, 17% were neutral, 54% agreed and 24% strongly agreed.

Figure 7: Opinions related to any technical problems experienced with the CAIT

	Steps are easy to follow	**Easy to move from one screen to another**	**Procedure is self-explanatory**	**I had little difficulty with the technical aspect**
	% (n = 56)	% (n = 56)	% (n = 56)	% (n = 56)
Strongly Disagree	0	0	0	1.8
Disagree	7.1	0	7.1	28.6
Neutral	26.8	21.4	39.3	21.4
Agree	53.6	64.3	48.2	39.3
Strongly Agree	12.5	4.3	5.4	8.9

The reference tutorial link on the CAIT, the debriefing discussion session and the computer-generated report of the student's performance were felt to be helpful by up to 68% of the students (Figure 8).

Figure 8: Opinions about the helpfulness of the tutorial link, debriefing and report

	Tutorial link provided useful information	**Debriefing session was helpful**	**Report was helpful feedback**
	% (n = 53)	% (n = 53)	% (n = 55)
Strongly Disagree	1.9	0	1.8
Disagree	3.8	1.9	12.7
Neutral	26.4	30.2	21.8
Agree	62.3	58.5	56.4
Strongly Agree	5.7	9.4	7.3

B. Evaluation of Students' Learning after Using CAIT

Students' Performance as Monitored by the CAIT

Figure 9 is part of the tracking record (showing in chronological order, only the history and physical examination sections) of a student. The presenting complaint is a cough in a middle-aged woman. The student's approach was not organised and not focused on the person with that complaint, e.g. her worries, travel history or contact with pulmonary tuberculosis. Little attention was given to general preventive measures like menstrual history, contraceptive method, blood pressure, and body mass index. (A doctor should think about prevention and make use of the opportunity of the consultation to practice preventive care. e.g. checking blood pressure and weight. For a female patient, it is important to know if she may be pregnant if medications are to be prescribed.) It would then be useful to have discussion on the wider view of holistic care and opportunistic prevention in primary care consultations.

Figure 9: The sequence of questions asked by a student on one simulated patient

History	Selection	Physical examination	Selection
	cough		chest shape
	sputum / phlegm		chest accessory muscle
(suggested choices:20 maximum choices:40)	blood in sputum	(suggested choices:10; maximum choices: 20)	respiratory rate
	throat soreness		chest percussion
	fever		chest auscultation
	sneezing - sneeze		nose
	aggravating factors		throat
	relieving factors		ear
	headache		heart inspection
	wheezing - wheeze		heart palpation
	occupational history		heart auscultation
	family, environment		pulse
	dyspnoea		
	age		
	past history		
	drugs, past intake		
	pain - ear		
	smoking history		
	alcohol intake		
	allergies		
	allergies to drug		
	nasal obstruction		

Curriculum Assessment

The module examination results of group A (92) and group B (60), those who had not tried the CAIT and those who did, were compared. There was no statistically significant difference in scores between the two groups at the end of module clinical examination, in terms of history taking and problem-solving.

Discussion

Most students found the CAIT interesting and innovative. Although some of them found it not as user-friendly as expected, most had little difficulty with the technical aspect on the second attempt.

With the production and use of these CAIT tutorials, we wish to augment students' clinical experience by broadening their exposure to structured encounters with patient problems in the local context. Students were given the extra opportunity to practice solving patients' multi-faceted problems. They were then able to obtain immediate individual feedback in a safe environment without fear of making mistakes on, and in front of, an actual patient or in front of a teacher and the whole class. They were required to work through the problems step by step by themselves and could not 'hide' amongst others in a group. As the number of cases produced was small, it is understandable that there was no difference between the groups in their summative assessment.

Now that the evaluation period is over, all students will have the benefit of being exposed to both the regular tutor-led tutorials with role-plays as well as the CAIT. With the record of the student's approach of a case, and particularly of several cases over a period of time, the student's strategy can be shown and discussed in the formative assessment. The test scores and errors in problem-solving can be monitored and the cumulative performance of students will allow the teachers to identify the common areas of weakness and place more emphasis on those aspects during their teaching.

Since most students felt that they could attempt the CAIT without the guidance of a tutor, the CAIT bank can be expanded and students will be able to access it in their own time following an initial briefing. A student may send queries by leaving messages at the end of the tutorial or e-mail them to a member of the teaching staff who may discuss with the student over the network or, if necessary, arrange a face-to-face discussion. A debriefing session near to the end of the module can be arranged to discuss any difficulties or queries encountered, and the lessons learnt from the tutorials.

The CAIT method and some of the cases may be adapted for use by other disciplines e.g. other medical and para-medical disciplines which involve clinical problem- solving, as well as disciplines which use counseling, e.g. social work, clinical psychology, psychiatry in which videotaped CAIT will be valuable.

Conclusion

A computer-assisted interactive tutorial that utilises multi-media technology and simulates problem-solving in Family Practice has been produced. This CAIT is unique because the authoring programme is simple to use such that local audiovisual clips of patient interviews can easily be added to create simulations within a local cultural context. The CAIT encourages its users to develop a holistic approach by requiring multi-dimensional problem-detection and identification. Students have to learn to make decisions in information gathering and justify their choices. The CAIT also has the advantage of providing structured clinical exposure and allowing students to work through a wide variety of patient problems safely and independently, without harming or embarrassing the patient. The experience can then be a springboard for group discussion. The CAIT also enables the teacher to study how the students gather information and generate diagnostic hypotheses to see if learning and maturation have occurred.

Acknowledgement

The support of the Action Learning Project Committee and the work of our computer consultant are gratefully acknowledged.

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