Teaching problem handling in general practice: a computer assisted learning software package for medical students

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SUMMARY. A computer assisted learning software package for medical students, EnMesh, designed to increase understanding of the problem-handling skills needed in general practice has been developed at the University of Liverpool. Users access the system anonymously and respond in sequence to problems in the form of clinical vignettes. Responses to each problem, in the form of up to six two-line text statements, are generated by the user with a simple word processing facility. Users compare their responses with those of established general practitioners, searching for similar or matching ideas. After completing not less than four problems users are provided with feedback on their performance in relation to the physical, psychological and social dimensions of the problems. The frequency with which the system is being used and the results of self scoring are monitored by a parallel teacher programme. The programmes are designed to run on a wide range of microcomputers.

EnMesh was designed to provide an informal learning resource within an established clinical course. The challenge of valid problems, the option to respond anonymously, self scoring and feedback on performance are features designed to attract student participation in computer assisted learning. Although in EnMesh the expert data is categorized in three dimensions, in designing such software the number of categories is limited solely by the range of responses which feedback is required to reflect.

Introduction

EXPERIENCE of and teaching about general practice is now firmly established in British undergraduate medical education.[1] There is still much variation in the contribution made by university departments of general practice to undergraduate curricula, reflecting among other things the teaching resources available.[2]

The recent commitment by the Department of Health to fund practice-based teaching of medical students directly through family health services authorities,[3] while long overdue, raises questions about the balance between university department and practice-based teaching in undergraduate education. Even if additional resources were granted to university departments on a similar scale (the so-called SIFT equivalent[4]) there are constraints of curriculum time and staff availability which may limit the capacity of departments to respond to this new opportunity. There is general agreement among medical educators that the undergraduate curriculum is over-crowded,[5] and pending radical review of this situation it is probably inappropriate for general practice to press for substantial additional teaching time. Rather, departments of general practice might look to more efficient use of the time and staff already available to them.

Academic departments of general practice in the UK have a tradition of teaching and assessment firmly based on current educational theory. The General Medical Council has commented favourably on their setting of learning objectives[6] and the departments have long embraced educational technology in the teaching of communication skills by video recording.[7] However, a recent literature search by the authors on computer assisted learning showed very few examples from general practice.[8]

Computer assisted learning takes many forms and is a rapidly expanding area of education; its ability to convey facts and increase skills is widely accepted.[9] Its application to learning in general practice might be seen as most appropriate to well-defined tasks (like drug prescribing). The challenge to academic general practice is to extend the technology to learning about situations of greater uncertainty, for example, the process of generating hypotheses about the aetiology and management of patients' problems, where a substantial difference exists between the level of skills of established practitioners and undergraduates.[10]

This paper describes computer software (EnMesh) which is intended to teach medical students about the approach of the community-based generalist clinician to problem handling. It is designed for unsupervised access by students, but it also generates material for tutorial discussion. Based on problems and responses provided by general practitioners, it enables students to assess their approach both quantitatively and qualitatively.

Within the overall aim of more efficient use of departmental teaching time there are two specific educational objectives of this system: to encourage greater autonomy of learning among students; and to provide the opportunity for students to address valid clinical tasks at their own rate within an academic department. Given the constraints imposed by a clinical service[11] both these objectives may prove elusive for students in the course of practice experience. Simulation exercises appear to offer educational advantages over reality.

Method

Between 1981 and 1985, one of us (I S) coordinated a programme of educational meetings for established general practitioners (Meshtel) in which geographically dispersed groups were linked by viewdata (for example, Prestel). Working simultaneously but separately, the groups considered and submitted responses to problems from clinical practice; later in the course of meetings the groups received feedback in the form of combined responses.[12,13] In this way problems were validated and the approach of a large number of general practitioners was obtained. Approximately 60 of these problems along with their collective responses form the basis of EnMesh.

Student access

The department of general practice in Liverpool provides teaching during four of the five years of the undergraduate curriculum; in the fourth year, students are attached to the depart-

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ment in groups of about 12, for a three week period. With tutorial teaching in a wide range of subjects and clinical experience in both city centre and rural/suburban practice, the timetable is already overcrowded. EnMesh was created for use by students between sessions and in their own time. The programmes are constantly available in the department on a single computer terminal, reserved for use by students alone or in small ad hoc groups.

System overview

EnMesh was written by one of us (C S) to run on a wide range of microcomputers (any IBM PC compatible machine). On entry to the system students must create a file name. This allows them to work on problems anonymously, and to return to the system on another occasion without being confronted by the same clinical problems. Thereafter general guidance is provided on how to approach the problems and the ways in which performance will be assessed.

Users assess and respond in sequence to problems in the form of clinical vignettes, attempting as many as they wish. Responses to each problem, in the form of up to six two-line text statements, are generated by the user with a simple word processing facility. After completing each problem the user is invited to compare the entered responses with those of established general practitioners, searching for similar or matching ideas. At any stage, the user can refer back to the corresponding problem or to a local help screen.

The responses of users and their assessment of the match between their own responses and those of established general practitioners are stored and used to provide feedback on performance. After completing not less than four problems performance is assessed and feedback provided in relation to the physical, social and psychological dimensions of the problems. Student responses and assessments, identifiable only by the chosen filename, are retained in the system for use by departmental teachers in discussion with individual students or as tutorial material.

Use of Enmesh

A user accesses the software from the hard disc (or after loading from floppy disc) with the password 'EnMesh' and the command 'enter.' After entering a personal file name of not more than six characters there follows an explanatory screen (Figure 1).

EnMesh has been created to test your approach to problems in primary care. You will be presented with a series of problems each involving a specific task. You will need to read the problem carefully and be quite clear of the task before attempting to respond.

Your response to each task will take the form of lines of text entered from the keyboard. In formulating these responses please remember:

a) the breadth of approach needed by the doctor in primary care
b) the exact nature of the task

Thereafter you will be shown the responses of doctors to each problem, and invited to score your performance. After completing four problems an analysis of your performance in terms of physical, psychological and social elements will be provided.

Teachers in the department may look at your self-scoring.

PRESS SPACE BAR TO CONTINUE

Figure 1. *Explanation of software.*

The user is then taken into an aptitude section. The four problems in this section have been selected to provide a roughly equal balance of physical, psychological and social elements. This provides the system with the best opportunity to draw preliminary conclusions about the strengths and weaknesses of the user in these dimensions of clinical problem solving, and to make recommendations about the area(s) upon which to concentrate in tackling further problems. An example of the first problem might be:

> 'Miss Green is a 24 year old student teacher of physical education. She is currently undertaking teaching practice. She has been unable to work for two weeks because of a respiratory infection associated with profound tiredness. Blood tests have confirmed your clinical suspicion of glandular fever. She has a consultation booked to hear the result of the blood test.
>
> List six distinct areas you feel it important to explore with her at this consultation.'

There follows a response screen which the student completes using simple word processing instructions available via an onscreen prompt. A typical completed student response screen to this first problem is shown in Figure 2.

1) How does she feel? Any complications of the illness?
2) Explain cause and management of glandular fever
3) Repeat blood tests
4) How did she get the infection?
5) Risk to other people
6) Explore how she was coping before the illness

For INSTRUCTIONS hold down the key marked CTRL and press I

Figure 2. *An example of a student's response to the above problem.*

Self scoring

On leaving the response screen the user is prompted by 'are you sure you are ready to mark this (Y/N).' If the Y key is pressed the user is presented with a list of 12 responses: the first 10 are typical general practitioner responses to the problem, the next is the option to claim that a student response is valid but unlisted; and the final response is for an inappropriate student response (Figure 3).

On the same screen the user's responses to the problem are shown in turn. As each student response appears the user must enter a code number (1–12) corresponding to the match (or matches) with the general practitioner responses, or the valid or inappropriate categories. If students wish to review the problem at this stage they may do so.

Taking the example problem and student's response the process of matching that students might undertake in seeking to score their responses can be followed. Student response (1) is straightforward since it appears to match only with general practitioner response (4). When '4' is typed-in, student response (1) is deleted and student response (2) inserted on the same screen. Response (2) is less clear-cut containing elements of general practitioner responses (1) and (2). The student therefore enters codes 1 and 2 (the system will accept up to four matches of this kind). Student response (3) is not reflected in the list of general practitioner responses. A review of the problem and task convinces the (fair-minded) student that this response is inappropriate and the code 12 is entered. Student responses (4) and (5) both match

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GP RESPONSES (1–10)
 1) Explain illness: aetiology, natural history, risk of
    complications
 2) Explain management of the uncomplicated case: rest
    at home
 3) Explore implications for work/career of interrupted
    teaching practice
 4) Look for signs/symptoms which suggest
    complications eg rash, jaundice
 5) Explore specific anxieties: eg route of infection, risk
    to others
 6) Explain management if symptoms persist or
    complications ensue
 7) Explore need to return home to family
 8) Explore any previous knowledge or direct experience
    of glandular fever
 9) Reassure that it is not serious
10) Check need for sickness certification/letter to college
    or GP at home
11) Valid but not listed
12) Inappropriate

STUDENT RESPONSE
 1) How does she feel? Any complications of the illness?

This response corresponds to number(s) ____

For INSTRUCTIONS hold down CTRL and press I
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Figure 3. *Typical responses of established general practitioners to the problem.*

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YOUR SCORE ON THE THREE CATEGORIES OF
RESPONSES IS AS FOLLOWS:

PHYSICAL
0    1    2    3    4    5    6    7    8    9    10
:    :    :    :    :    :    :    :    :    :    :
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx-----------------
(unsatisfactory)   (borderline)   (satisfactory)   (exceptional)

PSYCHOLOGICAL
0    1    2    3    4    5    6    7    8    9    10
:    :    :    :    :    :    :    :    :    :    :
xxxxxxxxxxxxxxxxxxxxxxxx---------------------------
(unsatisfactory)   (borderline)   (satisfactory)   (exceptional)

SOCIAL
0    1    2    3    4    5    6    7    8    9    10
:    :    :    :    :    :    :    :    :    :    :
xxxxxxxxxxxxx--------------------------------------
(unsatisfactory)   (borderline)   (satisfactory)   (exceptional)
```

Figure 4. *Example of a student's cumulative score.*

general practitioner response (5) and this code is therefore entered twice. Student response (6) is not reflected in the general practitioner responses. However, after further review of the problem and task, the student decides that it is valid and enters code 11.

At the end of this process of self scoring students are asked if they are happy with the matches allocated (Y/N). If students select N a list of the matches allocated appears on the screen and students can then alter any of these.

Feedback

The process is replicated by the student for a total of four problems in the aptitude section. Thereafter a cumulative score is presented to the user in diagrammatic form (Figure 4).

Users are then asked if they wish to respond to further problems and if so which category of problem: physical, psychological or social. It is pointed out that they will gain most from working in their weakest areas. Additional feedback on performance is available after users have attempted further problems.

Technical issues

Deriving feedback

The programme adapts the process of self scoring, which is essentially quantitative, to derive qualitative analysis and feedback. All the general practitioner responses have been categorized according to their physical, psychological or social content; and each response has been weighted by apportioning a weighting of six between these three categories. For example, if a response were classified as predominantly physical then it would carry a physical weighting of six with psychological and social weightings of zero. If on the other hand the response were considered to be equally physical, psychological and social in content, all three weightings would have the value two.

The programme calculates student performance on quantitative (number of matches) and qualitative (weighting of matches) criteria for each problem attempted, and presents feedback on cumulative performance over not less than four problems. In calculating performance the programme employs the principle of threshold values above which the score is capped or below which the score is considered invalid. This is necessary in order that duplicate or fractional matches can be scored: the maximum score achievable by a student response, however many general practitioner matches, is one unit; likewise, the maximum donatable by any general practitioner response, however many student matches, is also one unit.

With the majority of problems and responses this technique works well. However, where the problems attempted by the user contain very few responses within one category (for example, social) then the results are considered invalid for the purposes of feedback. In these exceptional circumstances a message to this effect is displayed.

Programming language

Turbo pascal proved to be ideal for the development of EnMesh because of its portability and appropriateness for text-based applications. Moreover, turbo pascal possesses the flexibility of a high-level language, the capacity to create complex record structures and excellent string handling facilities.

Reactivity

The speed of reaction of software is a critical issue in computer assisted learning. Rapid response to input is considered to be an essential feature since, among students, tolerance of delay is low. In EnMesh the design philosophy recognized this need and the structure of the programme was in part determined by it. A more detailed description of software design for EnMesh has been published elsewhere.[8]

Discussion

At present computer assisted learning for general practice is in its infancy,[14-18] in part because of the substantial investment required to take a project from idea to implementation. The

EnMesh project used clinical material in an appropriate format which had been validated elsewhere. It should be regarded as the first attempt to provide computer assisted learning software for general practice that aims to handle uncertainty by permitting free text entry and self assessment.

In the context for which it was designed EnMesh was required to change students' perceptions of computer assisted learning. Currently, few clinical medical students have much experience of or interest in computing and a minority are hostile to the notion of computers as sources of professional expertise. In the Department of General Practice at Liverpool we have recently introduced a course on medical informatics for first year students with the aim of changing these perceptions. With EnMesh we aimed to provide an informal learning resource within an established clinical course. The challenge of valid problems, the option to respond anonymously, self scoring and feedback on performance are features designed to attract student participation in computer assisted learning.

During the development phase of the EnMesh project departmental teachers were kept informed about it and some were sceptical of its value. However, following involvement of students in EnMesh teachers will inevitably be required to respond to individual or group learning needs. For this reason a parallel teacher programme was designed whereby teachers can determine the frequency with which the system is being used, decide whether self scoring is generating appropriate feedback and identify any learning needs.

We regard self assessment as a valid professional task for senior medical students, particularly if learning is reinforced in the process. In EnMesh self scoring is a process involving critical analysis of the users' responses, the given responses and the nature of the problem — itself a valuable educational activity. When undertaken in small groups the exercise stimulates discussion and shared learning. Clearly, feedback on performance is more meaningful to students if it reflects the breadth as well as the number of responses. Performance is expressed in graphic format and is provided both on the screen and, if requested, as a printout. The latter forms a useful starting point for discussions between students and members of staff.

In deriving feedback we have adopted a categorization of responses which, if somewhat dated,[19] is nevertheless still widely used in general practice at postgraduate level. EnMesh handles partial matches between student and expert responses in a pragmatic way and allows the student to credit ideas which lie outside the expert data base. It may be argued that such a process could lead students to generate inappropriate assessments and feedback. It is for this reason that monitoring by teachers is an integral part of EnMesh.

Computer assisted learning based on free text entry with monitored access and self scoring would appear to have many applications. Although in EnMesh the expert data is categorized in three areas, in designing such software the number of categories is limited solely by the range of responses which feedback is required to reflect.

We propose to evaluate EnMesh in terms of the level of student use, the reliability and validity of self scoring and the perceived benefit to student learning. The programmes have recently been made generally available to undergraduate departments of general practice in the UK. As a result we anticipate that wider evaluation based on observation and outcome of student use will become available to us.

What is already clear is that EnMesh encourages participation as a group activity. Ridgway has pointed out that when computer assisted learning is used in this way the interaction is beneficial, and should be a major goal of software developers.[20] Our initial impressions are that Liverpool students have a definite tendency to perform better on physical aspects of problems than on the psychological and social aspects. Moreover, this tendency appears to lessen as more problems are attempted.

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