SERIES ON EDUCATION Series editors: Anthony D Woolf, Michael Doherty

How should we be teaching our undergraduates?

Jane E Dacre, Robin A Fox

Medical education has changed significantly over the past two decades in many European countries. Rheumatologists have kept up to date with this change by becoming involved in curricular reform, and with the development of national,[1] and European[2] rheumatology curricula for undergraduate and postgraduate education Most of the examples of change cited in this article are based on the UK medical schools, but it is likely that these changes are reflected in other European countries. In addition, medical schools are in the midst of the implementation of substantial reforms of their own curricula after the General Medical Council recommendations.[3] The quality of rheumatology teaching is in the process of being evaluated as part of the Quality Assurance Agency visits, and there is likely to be an increasing demand for teachers in higher education (including medicine) to be trained following the Dearing report.[4] Provided that we can continue to keep abreast of these changes the standard of undergraduate teaching in rheumatology will improve considerably.

One of the current themes of medical education is that it has become recognised as a lifelong process.[5] Our undergraduates need to acquire learning skills that will take them from their undergraduate experience, through their general clinical training, specialist registrar training, and continuing medical education as consultant rheumatologists. Another theme is the shift from a teacher centred approach, where the emphasis is on the teachers and what they do, to a learner centred approach, where the emphasis is on what the students learn. To achieve this shift, a learning facilitator replaces the traditional didactic teacher, and traditional didactic teaching methods are replaced by interactive teaching in smaller groups.

The principles behind these methods are based on a body of educational research that has identified characteristics related to effective university teaching and learning. The aim of this article is to refer to the background educational theory, and to outline newer teaching methods developed on this basis. We hope also to provide a practical guide for our rheumatology teachers (and learners) in this new millennium.

Research Centre for Medical Education, 4th Floor, Holborn Union Building, Royal Free and University College Medical School, Archway Campus, Highgate Hill, London N19 3UA, UK
J E Dacre
R A Fox

Correspondence to:
Professor Dacre
Email:
j.dacre@chime.ucl.ac.uk

Accepted for publication
23 February 2000

Table 1 Learning styles

Learning style	*Student motivation*	*Process of study*
Surface	To complete the course Fear of failure	Little interest in content of the subject Rote learning of facts
Deep	Interest in the subject The need to understand Relevance to vocation	Identify general principle Integrate material across subject areas Relate ideas to evidence
Strategic	Desire to succeed To achieve high marks/grades To compete with fellow students	Any technique seen to achieve high marks Patchy and variable understanding

Student learning

Students' approaches to learning depend on their learning style as well as the learning environment and context (teaching and department characteristics).[6]

Table 1 shows three main types of learning style. Adult learners differ from children in several ways. Traditional medical education has often cast our students in the role of the child for the purposes of their education, enhancing knowledge acquisition (surface learning) without understanding the meaning of what is learnt (deep learning), and its importance in the clinical context. Medical students have been shown to enter medical school with a deep approach to learning, but after a few months their deep scores decrease and surface scores increase significantly.[7]

The importance of learning style can be seen in that:

- Deep/strategic but not surface learning predicts success in UK medical finals[8]
- Practising physicians have higher deep and lower surface learning scores than students[9]
- Deep but not surface styles make it easier for postgraduates to keep up to date and maintain competence.

Learning styles predict performance in the final year of medical school, but not at medical school application. [8] This suggests that learning style is to some extent modifiable. Our teaching methods should aim at encouraging a deep learning approach.[10] Box 1 shows guidelines for achieving this.

Maslow suggested a hierarchy of learning requirements (table 2).[11] Failing to satisfy the early stages risks students failing to learn. Students learn best if they feel safe in their learning environment (stage 2). Teaching by humiliation is not conducive to learning and should not occur—even if you survived teaching under such circumstances. This ideal learning environment is quite different from the typical undergraduate medical education, which is often characterised by sleep deprivation (on call or self inflicted), intimidating bedside teaching, and studying alone.[3]

Box 1 Guidelines for encouraging deep learning

- Course objectives encouraging higher intellectual skills (for example, problem solving), and the development of appropriate attitudes
- Reduced didactic (for example, lecture based, fact loaded teaching) and increased small group and self directed learning
- An interactive approach that encourages student questioning
- Developing end of firm assessment methods that reward "deep" rather than "surface" learning (for example, using extended matching (EMQ) and appropriately designed objective structured clinical examinations (OSCE) rather than multiple choice (MCQ) questions

Table 2 Hierarchy of student learning motivation (modified from Maslow[11])

Stage	*Learner's motivation*
1	Physical needs (e.g. hunger)
2	Emotional needs (e.g. feeling safe)
3	Social needs (e.g. feeling part of a group and not alone)
4–5	Learning begins (after steps 1–3)

Teaching methods

Newer teaching methods are designed to stimulate our students' adult learning characteristics. The principles of adult learning need to be considered in the application of these methods. Box 2 summarises these principles.

A selection of contemporary teaching methods applicable to rheumatology will now be discussed. Clearly, some of these require training to be implemented effectively, but such courses are now becoming more widely available. Many medical schools—for example, the Royal College of Surgeons, and the Arthritis Research Campaign, run regular courses in the UK.

TEACHING IN SMALL GROUPS

Learner centred teaching approaches are most effective in small groups.[12] Medical school teachers are frequently asked to teach in small groups. This teaching may be based at the bedside, or in a seminar room. These groups can be used to stimulate deep learning, and develop the students' higher intellectual skills, such as reasoning and problem solving. In the past, teachers have not always done this, but instead have just given a lecture to a small group of students. The aim of small group sessions is to involve all the students in active discussion, and thereby facilitate active learning. This is done by giving the group a purpose, or task. Reasons for the sessions and their purpose in the course should be clearly explained. Sometimes, it is necessary for the students to do some preparation beforehand, and this should be made clear. Students benefit most when the group is run in an open, trusting, and supportive manner. It is the role of the teacher (facilitator) to ensure that this happens. Box 3 shows a simple programme for such a session based around a rheumatology patient.

Box 2 Principles of adult learning

- Students should begin by identifying what they know and don't know about a topic
- All sessions should have clear objectives
- Sessions should begin with concrete examples (for example, a patient) not complex theory
- Students only learn what they have to; teachers should extrapolate from this and provide adequate assessment of important topics and concepts
- Teachers are supportive facilitators not providers of information or intimidating ogres
- Students should be given feedback to allow them to assess their strengths and weaknesses

Box 3 Example of a small group rheumatology teaching session

1 Student takes a history and examines a patient with symmetrical polyarthritis (work done before the session)
2 Small group session
- Objectives are stated (5 min)
- Students present case (10 min)
- Group is asked to write down five differential diagnoses (5 min)
- Group discusses list of diagnoses and prioritises them (10 min)
- Group subdivides to discuss necessary investigations (5 min)
- Students present those that were done (5 min)
- Subgroups discuss and compare investigation lists (10 min)
- Group leader concludes and summarises (5 min)

Groups work better with a clear timetable and a clear set of objectives, so that the discussion is orderly and purposeful. It is often helpful to vary the activity by dividing the students into twos or threes, and ask them to consider a particular aspect of the topic, and then come together again after 10 minutes. It is also useful to stop at intervals to review the group's progress.

Many clinical teachers are very experienced in this kind of teaching; the main skill, however, is dealing effectively with the more difficult group members.[13] Challenging behaviours include the persistent talker, the quiet student, and students with a negative attitude.

The chatterbox (the persistent talker)

This type of group member is enthusiastic, good, knowledgeable, but dominates the discussion at the expense of the more diffident group members. The facilitator can redirect the enthusiasm to other group members by techniques like summarising the main points, then directing questions to other group mem-

bers. Sometimes the problem is that the student rambles and goes off the point. This can be checked by techniques like redirecting their discussion when they pause for breath, and suggest they discuss the side issue outside the session. Sometimes there is a student who jumps in and eagerly answers all the questions. This can be limited by dividing the group into subgroups, and asking them to discuss the answers before giving them, or by suggesting that several students should give an option. Sometimes, the persistent talker is talking to his neighbour. The facilitator can regain control of the agenda by stopping the session until he realises his error, or asking him if he has something to share with the group.

The clam (the quiet student)

This kind of student often underperforms in a group, but may be very competent. It may be helpful to try to draw them into the conversation by name. Sometimes, subdividing the group works on this kind of student by allowing them to bounce their idea off a colleague, and thus feel more confident about it. Their contributions should be explicitly valued; asking a supportive group member to consider the shy person's point can do this.

The smart Alec (the negative attitude)

Occasionally, a student feels that he knows it all already. It may work if you flatter him, and ask him to allow the others to benefit from his superior experience or to explain that people learn best by active discussion, where everyone shares their knowledge and experience. Some students complain and whinge constantly. This can be minimised by getting them to be specific about the problem, acknowledging legitimate problems, and asking them to try to focus on the positive aspects. A joker can also be difficult to handle. Asking them to make a serious contribution can control this behaviour, or reinforcing any serious contribution they may make. Perhaps the most difficult group member to control is the aggressive and hostile person. It is worthwhile trying to rephrase their comments in a less confrontational way. If they create a lengthy negative debate, try to agree to disagree, and change the subject. Another technique is to acknowledge their opinion, and ask the rest of the group if they agree with him. Other group members will often do your job for you. If all else fails, ask them to leave the group.

Finally, for any small group work to be successful with medical students, it needs to be made clear to them that their attendance is required at each session, and that the content of their group work will be assessed.

SELF DIRECTED LEARNING (SDL)

Self directed learning works best in small groups, and is a style of learning that enhances "deep" learning. The principles of SDL are that the student defines his own learning needs, sets his own objectives, identifies resources and uses them to enhance his learning, and then is able to evaluate the outcome.[3] These principles are broad, and allow wide interpretation. Many of the teaching methods discussed below adopt a self directed approach.

PROBLEM BASED LEARNING (PBL)

In this method of teaching, learning is based around problems, which the students consider using a self directed approach. It is an attempt to apply theories developed and evaluated in cognitive psychology research to educational practice.[14] The problems are often based on written clinical cases. Students discuss these cases in small groups, with the help of a tutor (not necessarily an expert). Students are encouraged to define what they know, and then what they need to know in order to understand the problem. The justification for this is based in learning theory, which suggests that knowledge is remembered and recalled more effectively (in a "deeper" way) if it is based in the context in which it is going to be used in the future. For example, if joint anatomy is learnt in the context of a case history of a patient with osteoarthritis of the knee.

The learning process follows a set sequence, as set out in table 1.[15] For example, if the case of osteoarthritis of the knee is used, students would be guided by the Maastricht approach. Their first task would be to clarify and agree any working definitions of terms they did not understand (for example, if the patient has a valgus deformity on examination, what does this term mean?). The next step would be to define the problems and agree which phenomena need explanation (for example, how can a valgus deformity be explained anatomically?). The third step would be to analyse the problem (students discuss the problem from their current level of understanding). From this discussion, they create possible working hypotheses. They then generate a set of learning objectives, and research these in smaller groups, and in their own time, by accessing learning resources, books, tutors, etc. In the final stage of the PBL session, students will report back, using their new knowledge, and discuss the problem from a basis of better understanding.

Problem based curricula have been successfully implemented in several medical schools world wide. Several UK medical schools have adopted this approach—some are exclusively problem based (Glasgow, Manchester, and Liverpool), and some use PBL among other learning methods.

Several advantages are claimed for this style of learning. It has been suggested as a practical and accessible way of including basic science material into clinical education.[16] However, some evidence suggests that it reduces acquisition of basic science knowledge.[17] It promotes deep learning, enhances self directed skills,[18] provides a more stimulating learning environment, and promotes interaction between students and staff, and across disciplines. There have been some problems in setting up PBL courses. They are expensive, demanding of staff time, and stressful.[15 19–21] So far, there is no evidence that PBL graduates make better doctors, or rheumatologists.

Portfolio based learning

Portfolio based learning is another example of a method developed to enhance skills in SDL.[18 22] An educational portfolio is a record of examples of a learner's work, which can be used for the processes of learning and assessment. The portfolio can range from a simple log book, of cases or procedures seen, to detailed case histories, with reflective accounts, or a critique of the encounter. Reflective practice is a term used to describe the process of internally examining and exploring an area of concern triggered by an experience. The portfolio is a vehicle for encouraging "reflective practice" among our undergraduates, as it requires them to review their experiences. Each portfolio is individual to the student, and is difficult to compile. It is the role of the teachers to define the required content, with clear guidelines about what should be included. For example, the student may be expected to include five rheumatology case histories, with a differential diagnosis and suggested investigations for each. He may also be asked to identify and discuss an issue of communication skills that related to one of the cases, with a critique of his own performance, or an ethical issue.

A portfolio is an excellent way to encourage students to review their own progress. It is a difficult method to assess. Agreement between assessors is poor as the content is extremely variable. More research is needed before this becomes a valuable tool for summative assessment. In the meantime it is an effective teaching tool.

Guided discovery learning

Guided discovery learning has developed because of the need to combine the best of traditional teaching with innovative methods. It is a mixture of the two approaches and is used by medical schools that are working to a new curriculum, and those in the process of curricular reform, particularly in Newcastle and Dundee.[23] The learning framework is introduced in a didactic manner, but students are given the responsibility to work in a self directed way within this framework. They may use a problem based approach or traditional experience in a ward setting. Students work with a detailed study guide[24] and may also need to carry a log book, or portfolio. The study guide indicates what should be learnt, and specifies learning outcomes. It helps students to set their own objectives and plan their learning. It identifies learning resources, and advises which to use, and how to get the best out of them. In some medical schools, study guides are available on the internet.

Teaching clinical skills

History taking, examination of the patient, interpretation of results, and performance of simple practical procedures are important components of the skills of the rheumatologist, and need to be learnt by all students. These skills are best taught in small groups, using the principles discussed earlier. Traditionally, clinical assessment of the musculoskeletal system has been considered complex, difficult to learn, and retention is poor even after only one year post qualification from medical school.[25] The GALS screen[26] has been shown to be a reliable and valid measure of functional ability[27] and has made locomotor history taking and examination more accessible to students. Introduction of GALS screen teaching to medical students results in performance of a musculoskeletal assessment to a level similar to other "major" systems (for example, abdominal) examination.[28]

Senior undergraduates need to become more competent in rheumatological history taking and in more detailed regional clinical examination. Students become confused by the apparent lack of consistency in the approaches used, particularly to clinical examination. It is helpful for them to understand that a range of history taking and examination techniques is acceptable, and that they will develop their own fluency with time.

WORKING WITH PATIENTS

Rheumatology patients are ideal for helping undergraduates with their history taking skills. They are relatively well, and tend to have fewer work responsibilities, with more free time. They also often feel the need to participate and help in hospital activities in order to give something back.[29] Patients can be invited to attend to help with teaching sessions outside busy clinics. Students can work with them and a facilitator to develop their history taking and examination skills. History taking sessions are observed by the facilitator, who can help with communication skills, to practise the order and structure of history taking, and to develop skills in making a diagnostic hypothesis. Patients can be briefed to respond to particular questioning styles. For example, they will be descriptive in response to an open question, and give only yes/no answers to closed questions. In addition, patients may learn to describe difficult social problems or personal and embarrassing problems related to disability to enable the students to practise discussing difficult areas. It is less stressful for a patient to add a realistic, but fictional social history, than continually to discuss their own problems. Actors can also be trained to simulate patient scenarios, but need to be paid. Standardised techniques (simulated patients) have been used and evaluated extensively in the USA and Europe.[30 31] In our rheumatology teaching, their sophisticated acting skills are often not necessary, but they are good for difficult communication skill issues.

An extension of this type of teaching has been developed specifically for rheumatology. It is known as the Patient Partner Programme, and is funded by a pharmaceutical company.[32] Patients are selected for training by consultant rheumatologists. Those with stable rheumatoid disease who are reasonably healthy, and with a teaching or healthcare background are thought to be most suitable. They undergo a three day intensive residential course and are enrolled as patient partners, subject to a satisfactory performance in this. Evaluation studies have shown that patient partners are at least equal to consultant rheumatologists in the teaching of

musculoskeletal examination techniques for arthritis.[33 34] Our patient partners have recently started running a whole morning session with the students, and no longer need a separate facilitator. We review their performance by assessment of the students at the end of their attachment.

Teaching critical appraisal

Rheumatology is an active research specialty, making it increasingly difficult to keep up to date. It is important for undergraduates on rheumatology attachments to understand the principles of critical reading of the literature in this area so that they can access and make use of the literature at an early stage. Students need to be able to assess why a paper was written, and how the work was answering a research question. They should be encouraged to read reviews to enhance their knowledge, and to look at the method used to write the review. To make sure it is a rigorous, comprehensive search, and analysis of published work, and not simply a point of view. They should learn to check that a survey is from a representative sample, and is using a validated tool. They need to understand the concepts of sensitivity and specificity in rheumatological diagnosis. They need also to have some understanding of qualitative research.[35] These skills develop with experience, and increase with increasing use of the scientific literature. Given a few clear rules to look for, students can use the literature and present critical appraisals of published work in small group sessions.

Teaching in outpatient departments

As fewer patients are admitted to hospital, we have a greater need to teach in outpatient departments. There are some advantages of outpatient teaching: patients are healthier, are giving their story for the first time, teaching is often one or two to one, but there are practical constraints. The solutions to most of these are organisational. To have time to teach effectively, it is necessary to decrease the number of patients that the teacher sees. One way is to limit the teaching to one teacher, who selects patients from a shared list. The other doctors in the clinic then have no students, and are therefore expected to be more efficient. Another way is to perform an audit of clinical activity[36] and cut down lists by discharging patients that do not necessarily need to be followed up (for example, some patients with osteoarthritis, who can be managed equally effectively in primary care). Clinic time can also be used more effectively for teaching by setting limited objectives for the session. For example, tell the students that during this clinic, we will be concentrating on making sure that they can examine a spine/shoulder/knee, and ensuring that they do. All of the principles of small group teaching also apply to the outpatient setting. Students benefit from the small group size and the interaction in outpatient departments. Applying some of the principles outlined in the discussion of new teaching methods will enhance their learning.

Teaching with new educational resources

Since the publication of the GMC's document, "Tomorrow's doctors", most medical schools in the UK have invested in the creation of a clinical skills centre. A purpose built area, designed to enhance the teaching of clinical skills in a safe environment.[37] Skills centres are often the most appropriate environment for newer style teaching. They have access to databases of real and simulated patients who can be invited up for teaching activities. They also have the facilities to simulate a ward or other clinical environments. In addition to patients, clinical skills centres may have computer facilities so students may gain access to the internet, or to interactive CD ROMs on rheumatology.[38 39] Several manikins and models are now available to assist in the teaching of rheumatology. There are lifelike action models which allow a student to practise a skill, ranging from examination of a joint to joint injection.

Assessment

Any teaching method needs to be matched by an appropriate assessment that relates to the objectives of the teaching. Thus it is important to ensure that our rheumatology curriculum matches the teaching that occurs and the assessments we make.

Students may or may not learn what is in the curriculum or what we teach, but they will learn what we assess them on (the "hidden curriculum"). Assessment drives learning—this concept has vital implications in thinking how we should teach our students. If we give the students an end of rheumatology firm assessment and only test knowledge, we will find our students spending a large proportion of their time learning factual knowledge using a rote (surface) approach. If we wish students to learn how to take histories, examine, and communicate with patients then we must assess them on these same skills. This will encourage the students to attend our teaching sessions and spend more time directly interacting with patients.[40] Newer performance based assessment methods such as the Objective Structured Clinical Examinations (OSCEs) are reliable and valid measure of a student's performance, and can be relatively easily used as an end of firm test in rheumatology. Box 4 shows the benefits of using an OSCE for student rheumatology firm assessments.

Box 4 Benefits of a rheumatology OSCE as an end of firm test

- Encourages students to spend more time learning to interact with patients and motivating them (assessment drives learning)
- Allows their clinical skills to be directly observed to ensure they are adequate (not just assumed)
- Ensures students are learning what we believe we are teaching them (teaching evaluation)
- Identifies areas required for individual student study
- Ranks student performance

Discussion

There has been increasing interest in rheumatology as a major clinical area in the undergraduate curriculum. This article has outlined some of the newer teaching methods available to us. The development of these methods has come from evidence in cognitive psychology, coupled with a practical need to change the way we teach. Evidence is still being collected to evaluate the new approaches, and teaching methods will develop further. Continued interest in undergraduate education in rheumatology is essential to ensure that this process continues in a sensible and effective way.

1 Doherty M, Dawes P. Student teaching, guidelines in the undergraduate curriculum in the UK. Br J Rheumatol 1992;31:409–12.
2 European Board of Rheumatology, UEMS. Core Curriculum available on the internet <http://www.eular.org/uems/default.htm>.
3 General Medical Council Education Committee. *Tomorrow's doctors. Recommendations on undergraduate medical education*. London: General Medical Council, 1993.
4 Report of the National Committee of Enquiry into Higher Education. *Higher education in the learning society*. London: Stationery Office, 1997.
5 Spencer JA, Jordan RK. Learner centred approaches in medical education. BMJ 1999;318:1280–3.
6 Newble DI, Entwistle NJ. Learning styles and approaches: implication for medical education. Med Educ 1986;20:162–75.
7 Coles C. How students learn. The process of learning. In: Jolly B, Rees L, eds. *Medical education in the millenium*. Oxford: Oxford University Press, 1998:63–82.
8 McManus IC, Richards P, Winder BC, Sproston KA. Clinical experience, performance in final examinations, and learning style in medical students: prospective study. BMJ 1998;316:345–50.
9 Newble DI, Hejka EJ, Whelan G. The approaches to learning of specialist physicians. Med Educ 1990;24:101–9.
10 Newble D, Cannon R. *A handbook for medical teachers*. Boston: Kluwer Academic Publishers, 1994:165–71.
11 Maslow AH. *Motivation and personality*. New York: Harper and Row, 1970.
12 Newble D, Cannon R. *A handbook for medical teachers*. Boston: Kluwer Academic Publishers, 1994:38–53.
13 Allery LA. Dealing with challenging group members. In: *Two sides of AL: teaching reflective practice*. University of Wales College of Medicine School of Postgraduate Medical & Dental Education, 1998: 4.
14 Dolmans D, Schmidt H. The advantages of problem-based curricula. Postgrad Med 1996;72:535–8.
15 Schmidt HG. Problem-based learning: rationale and description. Med Educ 1983;17:11–16.
16 Bouhuijs PAJ. The teacher and self-directed learners. In: Jolly B, Rees L, eds. *Medical education in the millennium*. Oxford: Oxford University Press, 1998:192–8.
17 Vernon DTA, Blake RL. Does problem-based learning work? A meta-analysis of evaluative research. Acad Med 1993;68:550–63.
18 Finucane PM, Johnson SM, Prideaux DJ. Problem-based learning: its rationale and efficacy. Med J Aust 1998;168:445–8.
19 Albanese MA, Mitchell S. Problem-based learning: a review of literature on its outcomes and implementation issues. Acad Med 1990;65:52–81.
20 Berkson L. Problem-based learning: have the expectations been met? Acad Med 1993;68(suppl):79–88S.
21 Snadden D, Thomas M. The use of portfolio learning in medical education. Medical Teacher 1998;20:192–9.
22 Challis M, Mathers NJ, Howe AC, Field NJ. Portfolio-based learning: continuing medical education for general practitioners—a mid-point evaluation. Med Educ 1997;31:22–6.
23 Harden RM, Davis MH, Crosby JR. The new Dundee medical curriculum: a whole that is greater than the sum of its parts. Med Educ 1997;31:264–71.
24 Holsgrove GJ, Lanphear JH, Ledingham IMcA. Study guides: an essential student learning tool in an integrated curriculum. Medical Teacher 1998;20:99–103.
25 Fox R, Dacre J, Ingham-Clark C, Scotland A. A comparison of the ability of pre-registration house officers (PRHOs) and medical undergraduates to examine the locomotor system [abstract]. EULAR Congress Abstracts 1999:85 (abstract 322).
26 Doherty M, Dacre J, Dieppe P, Snaith M. The "GALS" locomotor screen. Ann Rheum Dis 1992;51:1165–9.
27 Plant MJ, Linton S, Dodd E, Jones PW, Dawes PT. The GALS locomotor screen and disability. Ann Rheum Dis 1993;52:886–90.
28 Fox R, Martin J, McLure C, Dacre J. Can students learn a locomotor screening examination (the GALS screen)? A comparative study [abstract]. EULAR Congress Abstracts 1999:84 (abstract 321).
29 Wykurz G. Patients in medical education: from passive participants to active partners. Med Educ 1999;33:634–5.
30 Barrows HS, Abrahamson S. The programmed patient: a technique for appraising student performance in clinical neurology. J Med Educ 1964;39:802–5.
31 Stillman PL, Regan M, Philbin M, Haley H. Results of a survey on the use of standardised patients to teach and evaluate clinical skills. Acad Med 1990;65:288–92.
32 Gruppen LD, Branch VK, Laing T. The use of trained patient educators with rheumatoid arthritis to teach medical students. Arthritis Care Research 1996;9:302–8.
33 Hendry GD, Schrieber L, Bryce D. Patients teach students: partners in arthritis education. Med Educ 1999;33:674–7.
34 Branch VK, Lipsky PE. Positive impact of an intervention by arthritis educators on retention of information, confidence, and examination skills of medical students. Arthritis Care Research 1998;11:32–8.
35 Greenhalgh T. *How to read a paper*. London: BMJ Publishing Group, 1997.
36 Comer M, Dacre J. A post-Tomlinson London rheumatology service [abstract]. Br J Rheumatol 1994;33(suppl):108.
37 Dacre J, Nicol M, Holroyd D, Ingram D. The development of a clinical skills centre. J R Coll Physicians Lond 1996;30:318–24.
38 McCrea JD, McCredie MR, McSherry DM, Brooks PM. A controlled evaluation of diagnostic criteria in the development of a rheumatology expert system. Br J Rheumatol 1989;28:13–17.
39 Armstrong R. *Interactive rheumatology tutor CD Rom*. Cambridge: Cambridge University Press, 1997. (ISBN 0-521-62914-4.)
40 Newble DI, Jaegger K. The effect of assessments and examinations on the learning of medical students. Med Educ 1983;17:165–71.