Q J Med 2004; **97**:47–51
doi:10.1093/qjmed/hch008

Commentary

QJM

Interactive learning in medicine: Socrates in electronic clothes

M. BREZIS[1] and R. COHEN[2]

From the [1]*Quality & Safety Committee, Hadassah Hebrew-University Hospital, Jerusalem, and* [2]*Center for Medical Education, Hebrew University Faculty of Medicine, Jerusalem, Israel*

Summary

Traditional lectures have limited ability to maintain attention and to promote changes in behaviour. Active learning, which stimulates the audience to think and participate, may be more effective. We describe our experience with an interactive polling system in lectures to physicians and students. Audience's answers to questions are displayed, providing instant feedback to both lecturer and audience, and promoting the use of case discussions and problem-solving exercises. In our experience, this modality improves the quality of clinical learning and deserves further evaluation.

Introduction

Trends in education are shifting from passive to active learning, replacing the old metaphor of 'transmission of knowledge' with a new metaphor of 'dialogue'.[1] The failure of traditional lectures has promoted innovations such as problem-based learning and other interactive techniques, such as case discussions,[2] and the application of social marketing techniques may enhance their effectiveness.[3] The use of interactive voting systems is one way to engage audience participation: as the lecturer poses questions, the audience responds using wireless keypads, and a computer-based device displays the distribution of answers.[4] This technique, reminiscent of a TV game show, is being increasingly applied in undergraduate education, at post-graduate medical courses and at meetings, to promote active learning and to test knowledge or attitudes. Not only does this interactive mode promote group thinking and provide instant feedback to teacher and audience,[4] but the anonymity of the response facilitates a non-threatening mode of learning. We have been using an interactive voting system for teaching evidence-based medicine in academic hospitals and other related settings, for the last two years. Experience has been gained from over 25 lectures to nearly 500 physicians (including residents, board-certified specialists and primary care doctors) and from several courses to more than 400 students. We have found that this modality facilitates probabilistic thinking, listening to alternative options and the recognition of misconceptions, all major ingredients of modern clinical learning.

Application of Bayesian logic to diagnosis

Diagnosis combines clinical information with results from laboratory or imaging testing. This integrative task is poorly performed by physicians,[5] because of

Address correspondence to Professor M. Brezis, Center for Quality and Safety, Hadassah Hebrew-University Hospital, Ein-Kerem, POB 12000, Jerusalem, Israel 91120. e-mail: brezis@vms.huji.ac.il

humans are generally poor at combining probabilities. Interactive lecturing allows a quick appraisal of this skill among physicians exposed to a clinical vignette. Figure 1 illustrates the difficulty physicians have in assessing the probability of a disease when a screening test for HIV is positive in an apparently healthy individual. Answers gravitate around extremes (low or high probability), a finding consistent with mental anchoring to one piece of the available information: the healthy clinical background, or the positive reliable test.

A rational approach to diagnosis using Bayesian logic, can be performed graphically, as shown in Figure 2 and discussed elsewhere.[6] A shift in pre-test probability can turn around the post-test probability, and this would typically happen after a few clinical questions (of the type asked in a blood bank form, such as 'have you had unsafe sex or used intravenous drugs?'). Similar questions about the chances of breast cancer after a positive mammography or the probability of colon cancer after a positive occult blood test can be asked with the interactive system, illustrating the importance of pre-test assessment for a correct interpretation of any laboratory or imaging modality. Another application of the voting system is in polling physicians' perceptions about the probability of a diagnosis, when faced with a structured clinical vignette, before and after ancillary testing: the interactive exercise can demonstrate, for instance, how a high clinical probability of myocardial infarction is barely affected by a negative ECG (at rest or stress). Experience with large groups of medical students shows that interactive teaching facilitates probabilistic thinking and the application of likelihood ratios in diagnosis (see below): at the end of a session, most students would correctly combine pre-test and test information, and refuse to interpret a test result without a pre-test probability.

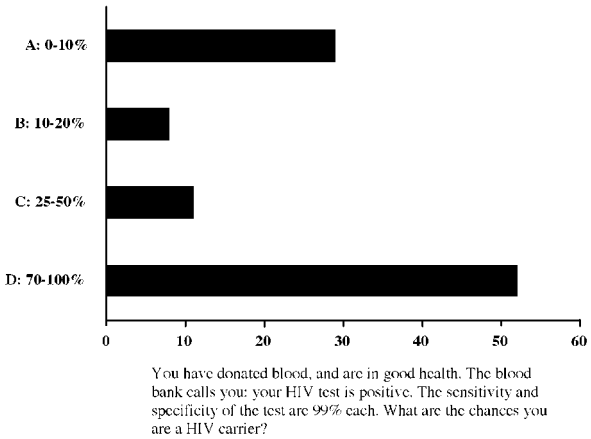

Figure 1. Distribution of answers to a diagnostic question, showing the cognitive difficulty in combining clinical and laboratory information. The histogram is derived from 242 answers in various audiences of physicians (from several teaching hospitals and specialties, including residents and senior physicians).

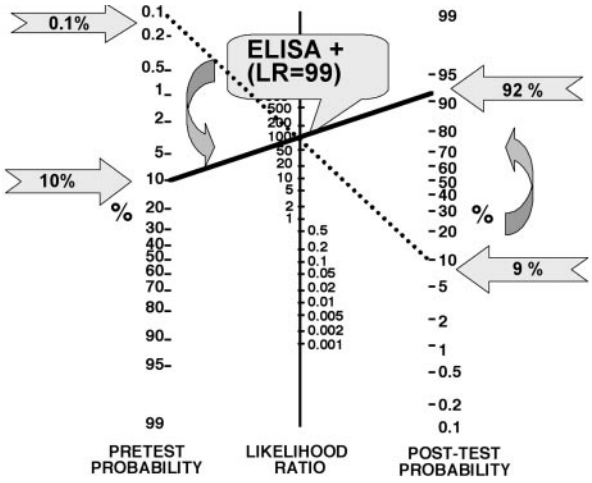

Figure 2. Nomogram to combine pre-test probability with information from ancillary testing (quantified by the likelihood ratio, LR, derived from the sensitivity and specificity of the test) to give post-test probability. If the pre-test probability of HIV carrier state is 0.1% (an average prevalence in a healthy population), the post-test probability is 9%. In the presence of risk factors, if the pre-test probability of HIV carrier state were 10%, the post-test probability would be 92%. The correct interpretation of a test result critically depends upon the pre-test probability. Interactive exercises can illustrate the value of focused clinical questions that shift pre-test probability.

Demonstration of ignorance and other hidden realities

Medical information is often poorly assimilated. Table 1 shows typically wrong answers to a common management question related to acute low back pain.[7] The anonymous mode of the voting system allows the friendly realization of knowledge gaps, essential for effective learning.[2] Similar observations were made in other areas: for instance, a majority of physicians (including obstetricians and internists) did not think that aspirin or calcium can prevent toxaemia of pregnancy, despite published systematic reviews;[8] a majority of primary-care physicians were not aware that physical activity can prevent diabetes mellitus or alleviate major depression. Polling the audience with questions pertaining to the information to be shared in a lecture allows rapid identification of weaknesses and construction of audience-tailored messages.[2]

The anonymity of the interactive system allows the uncovering of other facts often hidden by the

Table 1 A 44-year-old man has low back pain radiating to a leg for two days. What is your advice?

Answer	%
Bed rest for a week	12
Partial rest	50
Normal activity	0
Back exercises	29
Swimming	9

Distribution of answers by physicians, illustrating lack of knowledge of randomized trials that have shown inefficacy of rest and exercises in acute low back pain.[7] The anonymous mode of the voting system allows demonstration of ignorance. The distribution shown is from a group of orthopaedic surgeons ($n = 25$), but comparable results were seen in other audiences of physicians.

embarrassment inherent to open communications. For instance, asked about their own habits of physical activity, many primary care physicians admitted to exercising for less than one hour each week (a behaviour likely to impede their capacity to convince others to exercise). In interactive polling, residents admitted that after committing a mistake in their practice, they would be reluctant to report them to the patients or to the staff (a problematic attitude which could be discussed during a lecture on physician-patient communication). In the course of a lecture on 'do not resuscitate' orders, a majority of internists replied affirmatively to the query 'Has your team performed a 'slow code' during the last year?' They also admitted rarely discussing end-of-life decisions with patients and families. These data, generated during the lecture, provided an impetus for discussion of the need for change. In weekly homework exercises given to medical students and solved in class using the interactive system, we were impressed by the high rate of correct answers. Asked anonymously, over a third of the students admitted regularly solving the questions with help from classmates but without understanding the answer (so the polling system can even uncover its own limitations: stimulation to active learning needs more than an electronic device). The interactive system may promote open discussions after identifying that a problem is shared: it may convey the utility of transparency in improving health care.[9]

Teaching respect for autonomy by respecting autonomy

To what extent are physicians ready to reveal uncertainty of knowledge and to share partnership with patients in decision-making? As shown in Table 2, physicians were mostly reluctant to consider a patient's preference, despite the equivalence of options in randomized trials, in a question about the management of dyspepsia.[10] The polling system illustrates the acceptability of both options by the group, but a physician's choice is associated with failure to consider the alternative as legitimate. It seems that current clinical teaching does not promote patient-centred thinking for diagnosis and treatment options. We asked physicians: 'would you yourself take aspirin for primary prevention?', given an absolute risk reduction of 0.2% (for cardiovascular death) and absolute risk increase of 0.1% (for serious bleeding).[11] On repeated occasions, answers were nearly equally distributed between yes and no. The same ambivalence was observed when we asked physicians: 'would you want for yourself perioperative radiation for colorectal cancer?' given the controlled trials showing a few percentage points decrease in mortality from cancer at 5 years, at the cost of a small increase in non-cancer-related death at 1 year.[12] This interactive exercise illustrates the legitimate differences in subjective perceptions of benefits and risks. Since medical and surgical options often entail some risks in conjunction with benefits, personal views may lead to opposite decision about best treatment. The voting system has the capacity to show the value of others' thinking in aiming for optimal management.

Table 2 A 36-year-old woman has been suffering for years from dyspepsia (upper abdominal discomfort, not related to meals). What is your next step?

Answer	*n*
A. Endoscopy	12
B. *H. pylori* testing & Rx	9
C. Patient's preference for A or B	0
D. Don't know	1

Distribution of answers by physicians, showing reluctance to consider a patient's preference, despite equivalence of options A and B, as shown by randomized trials. The voting system illustrates the acceptability of both options by the group, but a physician's choice is associated with failure to consider the alternative as legitimate. The distribution shown is from a group of gastroenterologists ($n = 22$), but comparable results were seen in other audiences of physicians (answers A and B were always far more often selected than answer C).

Since Socrates, teachers have praised the didactic importance of questioning. The contemporary educator Janush Korzac (a physician and a pedagogue who chose to accompany the orphans under his care to the extermination camp Treblinka[13]) taught

us the values of nurturing independence in learning, and of selflessness in caring. As opposed to traditional expert lecturing, interactive learning may help teaching respect for autonomy by respecting autonomy.[14]

Technical aspects, limitations and evaluation

Several vendors exist for slightly different interactive teaching systems with an infrared-based communication technology. We paid around US$5000 for a system with 100 transmitters. The main disadvantages of any of these systems are the hardware issues (in addition to the computer, its software and the receiver, the wireless transmitters have to be distributed and recovered each lecture, unless the students buy them) and the question constraints (which have to be fixed-response, prepared in advance and appropriately integrated into the lecture). The introduction of such a teaching aid requires the development of a training program to expose faculty to the principle of active learning and provide them with the skills needed to use the equipment efficiently, including how to structure a lecture with appropriate questions.

Evaluation of the interactive response system by students revealed that 85% of students ($n = 230$) felt that the system to a great (or very great) degree promoted interest and participation in the lecture they attended. In analyses of the written comments by the students in response to the question 'what are the best aspects of the course?', the interactive system has been the single most frequent category mentioned by the students, for the two consecutive years in which the course has been offered. Other demonstrations of active learning can be seen in Figures 3 and 4. The modality appears to be logical, feasible, acceptable and congruent with current theory of adult learning, but there are still very few studies probing its effectiveness in general education,[4,15] and, as far as we know, none in medicine. It may particularly fit educational challenges that demand departure from attitudes, intuitive diagnosis or preconceived notions—by making them explicit.

Conclusion

From the Talmudic dialectics to modern philosophers such as Martin Buber,[16] many scholars have proclaimed the power of interpersonal dialogue for reaching truth and for the practice of humanitarian medicine. Today's technology allows an affordable voting system—an electronic, group

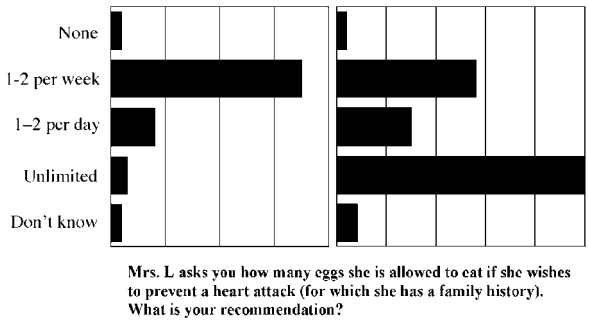

Figure 3. Demonstration of active assimilation of new knowledge during a lecture to medical students. The left histogram represents the first distribution of audience's answers. The right histogram represents the distribution of answers after presentation and discussion of the Cochrane review of randomized trials on the effects of dietary fat on coronary events. The downward shift of answers demonstrates rapid assimilation by the audience of the lack of strong evidence regarding the value of dietary cholesterol restriction.

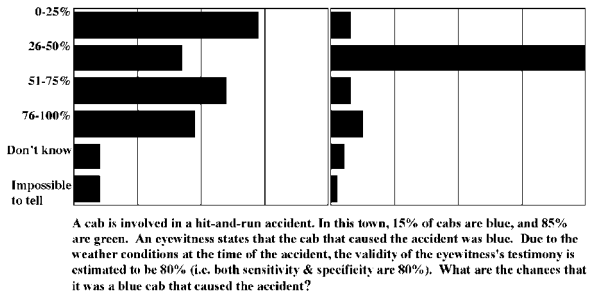

Figure 4. Demonstration of active learning in the combination of probabilities during a lecture to medical students. The left histogram represents the first distribution of audience's answers to a question demanding combination of probabilities (taken from Kahneman's and Tversky's work). After discussing the mental difficulty at this type of task, we explained how to work with a nomogram (Figure 2), which estimates post-test probability by combining the prevalence of a disease (or of an attribute: the blue colour of a cab) with the performance of a test (in this case, the eyewitness). The right histogram represents the distribution of answers 20 min later, a majority having found the correct answer.

version of the Socratic method—that facilitates interactive teaching and enhances lecturing in medicine. In our experience, this modality improves the quality of clinical learning and deserves further evaluation.

Acknowledgements

The authors have no financial relationship to any of the vendors of interactive teaching systems. We thank Professor Jochanan Benbassat, who

provided invaluable insights in reviewing the manuscript.

References

1. Meyers C, Jones TB. *Promoting active learning*, 1st edn. San Francisco, Jossey-Bass, 1993.
2. Mazmanian PE, Davies DA. Continuing medical education and the physician as a learner. *JAMA* 2002; **288**:1057–60.
3. David SP, Greer DS. Social marketing: application to medical education. *Ann Intern Med* 2001; **134**:125–7.
4. Dufresne RJ, Gerace WJ, Leonard WJ, Mestre JP, Wenk L. Classtalk: A Classroom Communication System for Active Learning. *J Computing Higher Educ* 1996; **7**:3–47.
5. Kahneman D, Slovic P, Tversky A. *Judgement under Uncertainty: Heuristics and Biases*. Cambridge, Cambridge University Press, 1982.
6. Halkin A, Reichman J, Schwaber M, Paltiel O, Brezis M. Likelihood ratios: getting diagnostic testing into perspective. *Q J Med* 1998; **91**:247–58.
7. Hilde G, Hagen KB, Jamtvedt G, Winnem M. Advice to stay active as a single treatment for low back pain and sciatica (Cochrane Review). *Cochrane Database Syst Rev* 2002; **2**:CD003632.
8. Duley L. Pre-eclampsia and hypertension. *Clin Evidence* 2002; **7**:1296–300.
9. Davidoff F. Shame: the elephant in the room. *Br Med J* 2002; **324**:623–4.
10. Delaney B, Moayyedi P, Forman D. Helicobacter pylori infection. *Clin Evidence* 2002; **7**:421–2.
11. Hayden M, Pignone M, Phillips C, Mulrow C. Aspirin for the primary prevention of cardiovascular events: a summary of the evidence for the U.S. Preventive Services Task Force. *Ann Intern Med* 2002; **136**:161–72.
12. Colorectal Cancer Collaborative Group. Adjuvant radiotherapy for rectal cancer: a systematic overview of 8,507 patients from 22 randomised trials. *Lancet* 2001; **358**: 1291–304.
13. Kulawiec EP. Janusz Korczak, physician-humanitarian. *JAMA* 1979; **241**:2165–6.
14. Williams GC, Deci EL. The importance of supporting autonomy in medical education. *Ann Intern Med* 1998; **129**:303–8.
15. Van Dijk LA, Van Den Berg GC, Van Keulen H. Interactive lectures in engineering education. *Eur J Eng Ed* 2001; **2001**:15–28.
16. Cohn F. Existential medicine: Martin Buber and physician-patient relationships. *J Contin Educ Health Prof* 2001; **21**:170–81.