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INTROSPECTION AND ACTIVE LEARNING IN BIOMEDICAL STUDY

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With a decline of staff ratios tending to reduce practical and tutorial teaching in biomedical curricula, we must find ways of replacing and maintaining - or even enhancing - important qualities of these labour-intensive activities in other ways. I have focused on ways in which computer-based study can help to train (a) the habit of introspection about the basis and the reliability of one's knowledge, through enforced confidence judgements, and (b) visual intuition about physical and mathematical relationships, through interactive graphical presentations.

A computer based delivery system (LAPT: London Agreed Protocol for Teaching) has been developed and used for several years on two London campuses with the special objective of encouraging students to think, whenever they answer a question, about the degree of confidence they can place in their answer (1). This helps them appreciate that a lucky right answer is not genuine knowledge, and it encourages them to check ideas by relating these to other facts and areas of knowledge. With low confidence (level 1) correct answers are given only a single mark, with no negative marking, while with higher confidence (levels 2 or 3) correct answers gain 2 or 3 marks, but carry the risk of increasingly severe negative marking (-2 or -6) if the answer is wrong. This rational use of negative marking (2) is popular with students, since they seem instinctively to appreciate the fundamental relationship between confidence and knowledge, and the importance of not making mistakes with high confidence. It alerts them to the particular value of paying attention in these circumstances to feedback and explanations, which are always presented immediately following the confidence judgement. The LAPT system is available for download from its web site (3).

Students often seem deficient in visual modes of thinking, especially about physical concepts in physiology like fluxes, currents, pressure and flow, and about statistical and graphical concepts like histograms, variance, regressions and rates of change. As scientists, we have usually built up mental pictures that aid our thinking on these topics, through long familiarity with different types of graphs and data. A symptom of students' deficiency in this respect is that they have seldom yet learned to sketch diagrams to help in discussion of a problem. It is nowadays quite simple to write graphical programs that enable students to interact directly with fast simulations of the relevant physical or mathematical systems, for example enabling them immediately to see smooth changes in graphs or physical behaviour, when they change parameters. Such active learning helps to build up the mental pictures that can be the foundation of clear thinking, and occasionally it dramatically makes concepts seem self-evident, where students otherwise have difficulty - for example in the relations between currents, fluxes, membrane area and resistance. The exercises are written with LABVIEW (National Instruments) and are available for download via the LAPT system (3).

1. Gardner-Medwin AR, 1995. Confidence assessment in the teaching of basic science. ALT-J (Assoc. for Learning Technology Journal: now renamed *Research in Learning Technology*) 3:80-85

2. Gardner-Medwin AR. Rational and irrational marking schemes. J. Physiol 515P: 48P, 1999

3. http://www.ucl.ac.uk/LAPT

INTROSPECTION AND ACTIVE LEARNING IN BIOMEDICAL STUDY

A. R. Gardner-Medwin

The problems:

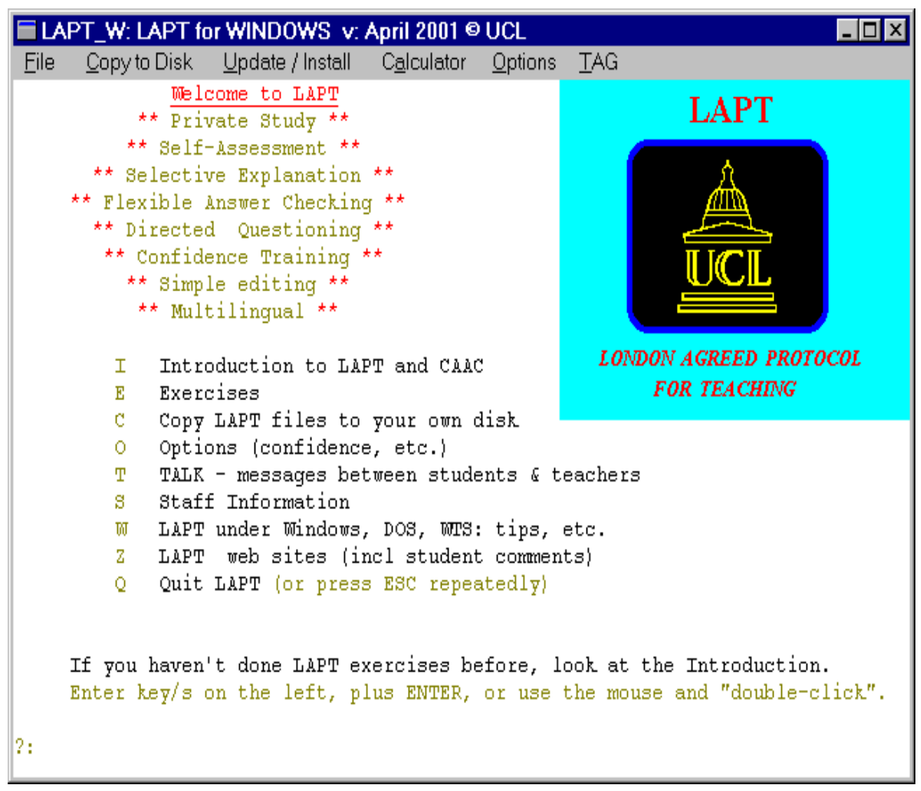
- Fewer staff, more students, less small group & practical teaching
- Rote learning: students focus on information, not understanding
- Poor introspection and concept manipulation

Some ways computers can help:

- Confidence-based marking to develop introspection
- Interactive simulation to develop visual intuition

LAPT - Confidence Based Assessment www.ucl.ac.uk/~cusplap

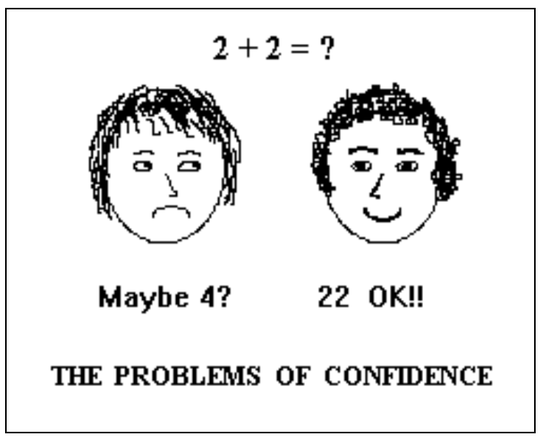
A versatile system for formative and summative assessment & CAL delivery, with a key objective to encourage students to reflect about the basis and reliability of their knowledge.



The LAPT confidence-based scoring scheme

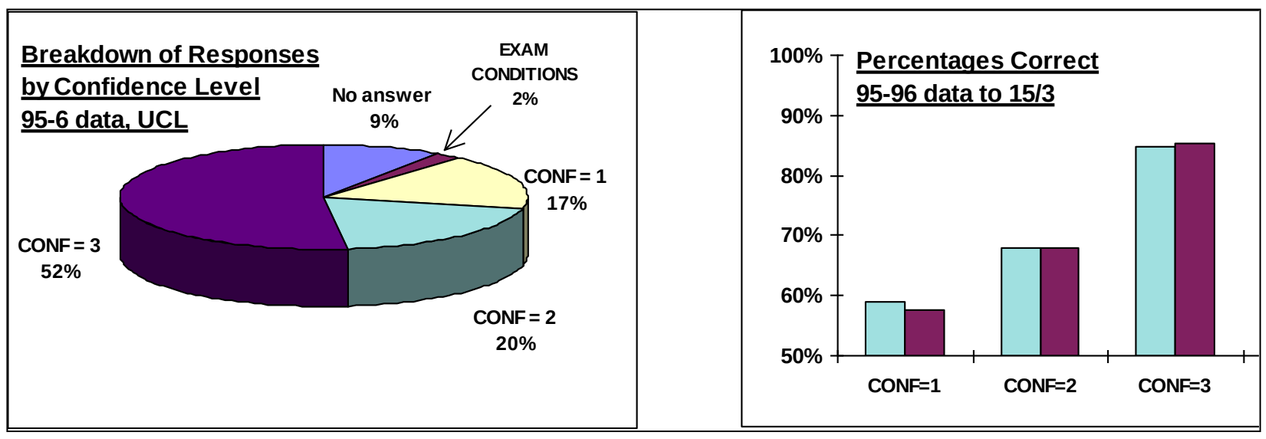
Confidence Level	1	2	3
Score if Correct	1	2	3
Score if incorrect	0	-2	-6
P(correct)	< 67%	>67%	>80%
Odds	< 2:1	>2:1	>4:1

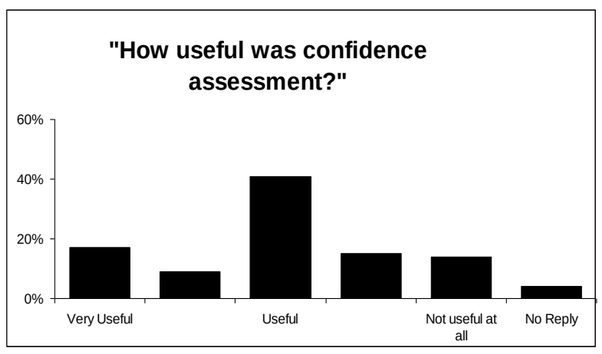
- Confidence assessment encourages students to think about what they base their answers on.
- They think about relationships to other knowledge.
- It encourages answer-checking and re-reading of questions
- It flags serious misconceptions (-6!) and alerts students to pay special attention to relevant explanations.
- It distinguishes true knowledge from a lucky guess

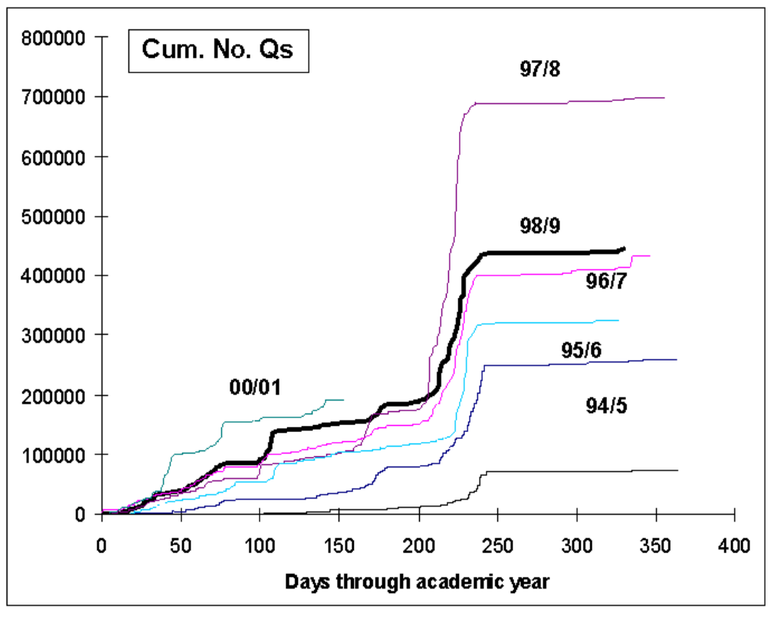


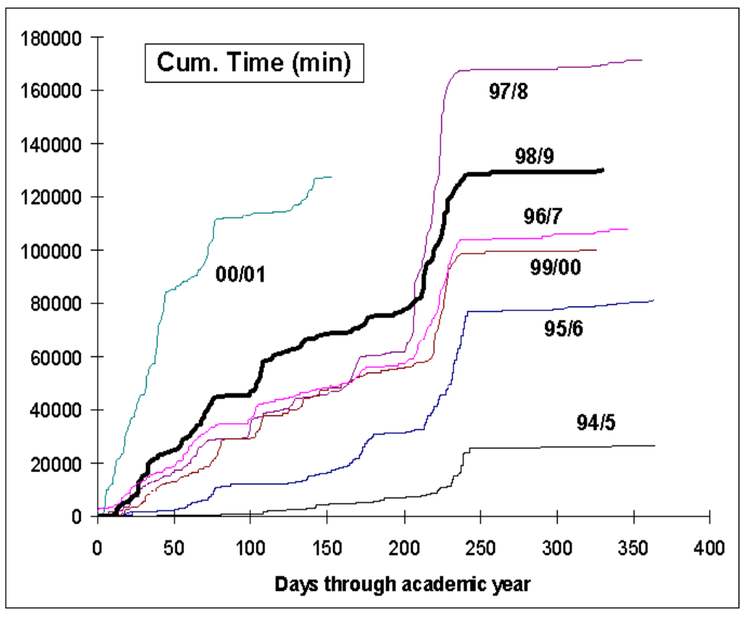
Evaluation & Statistics for LAPT and Confidence Assessment

- They understand the seriousness of confident errors
- They like the option to express low confidence
- They think about confidence and learn to discriminate correctly









LAPT use on UCL campus

NB An increasing fraction (>>50%) of LAPT use is at home on private computers. We encourage this with efficient downloading and updating facilities.

MATHS in Medical Science

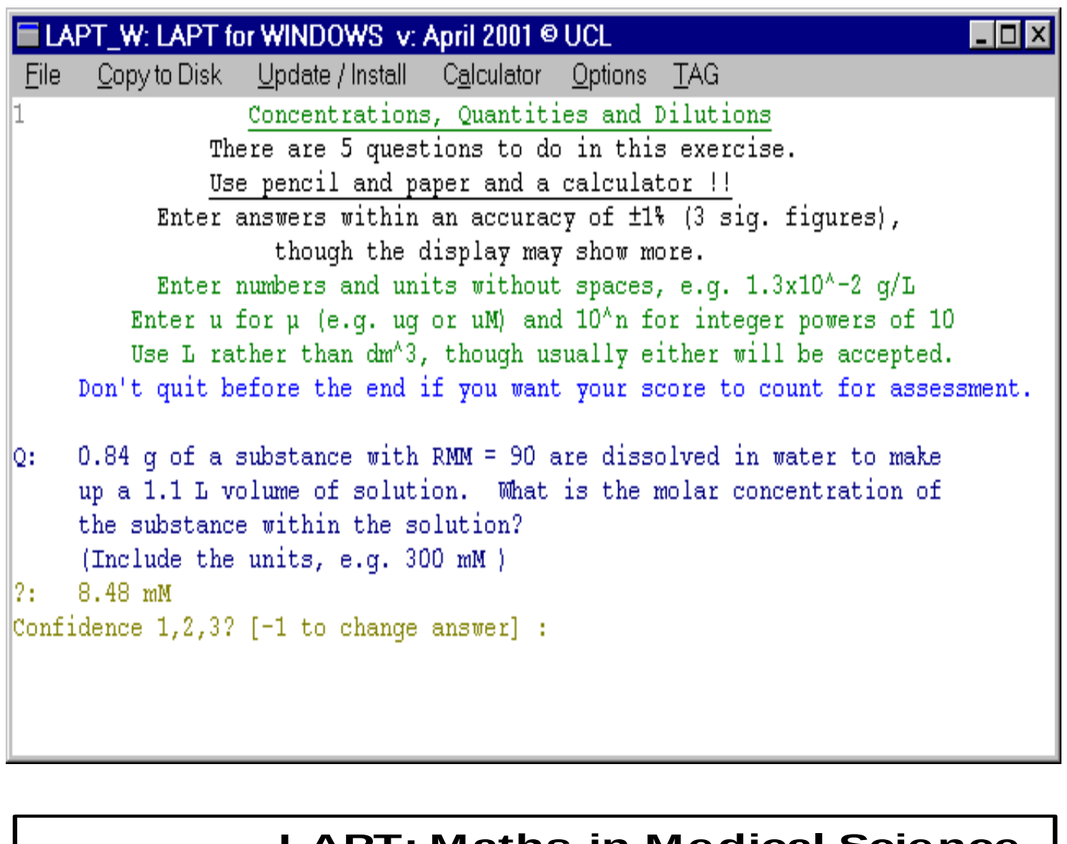
Some students have serious problems with numeracy, quantitative concepts, units etc. We have this year introduced short assessment modules on each of which students must reach 80% correct in their own time. Random parameters are presented on each attempt.

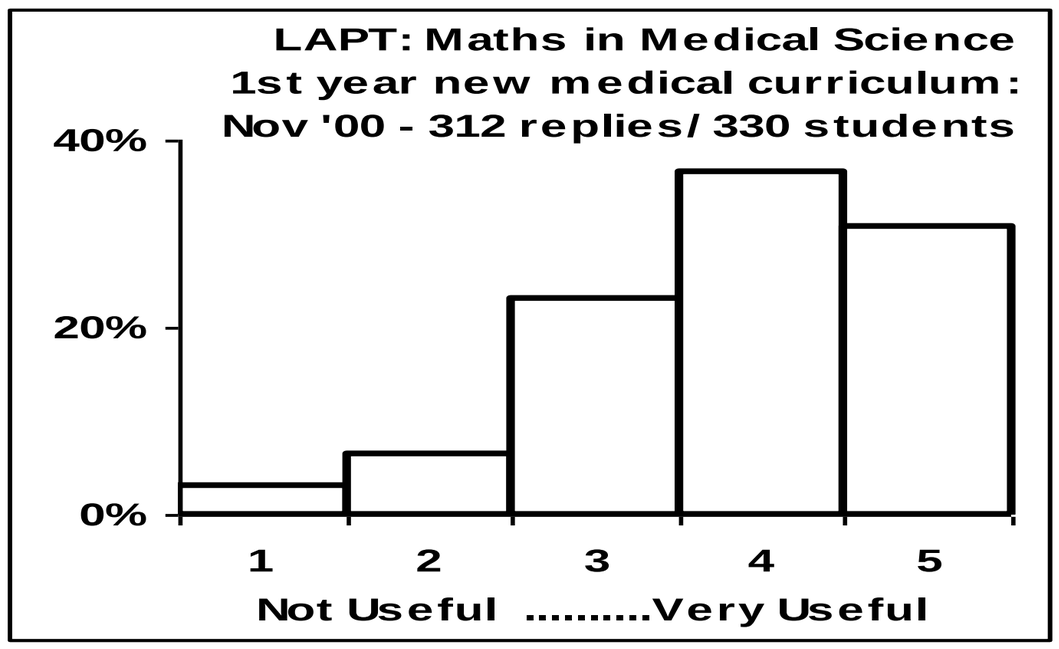
The topics were:-

- **Quantities, concentrations & dilutions**
- **Equations and Units**
- **Proportions, power laws and percentages**

97% of the students achieved the criterion of 4/5 correct on each exercise, but they took 3.6 ± 2.4 (mean ± SD) attempts to achieve this (not counting home practice).

Student evaluation was favourable (92% "useful" to "very useful").





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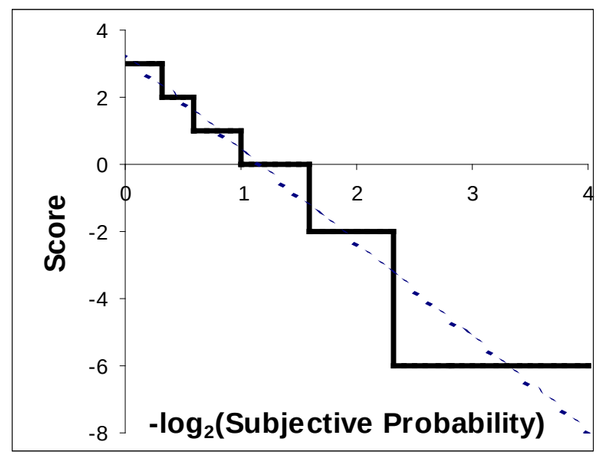
Confidence-marking has a well-founded theoretical basis

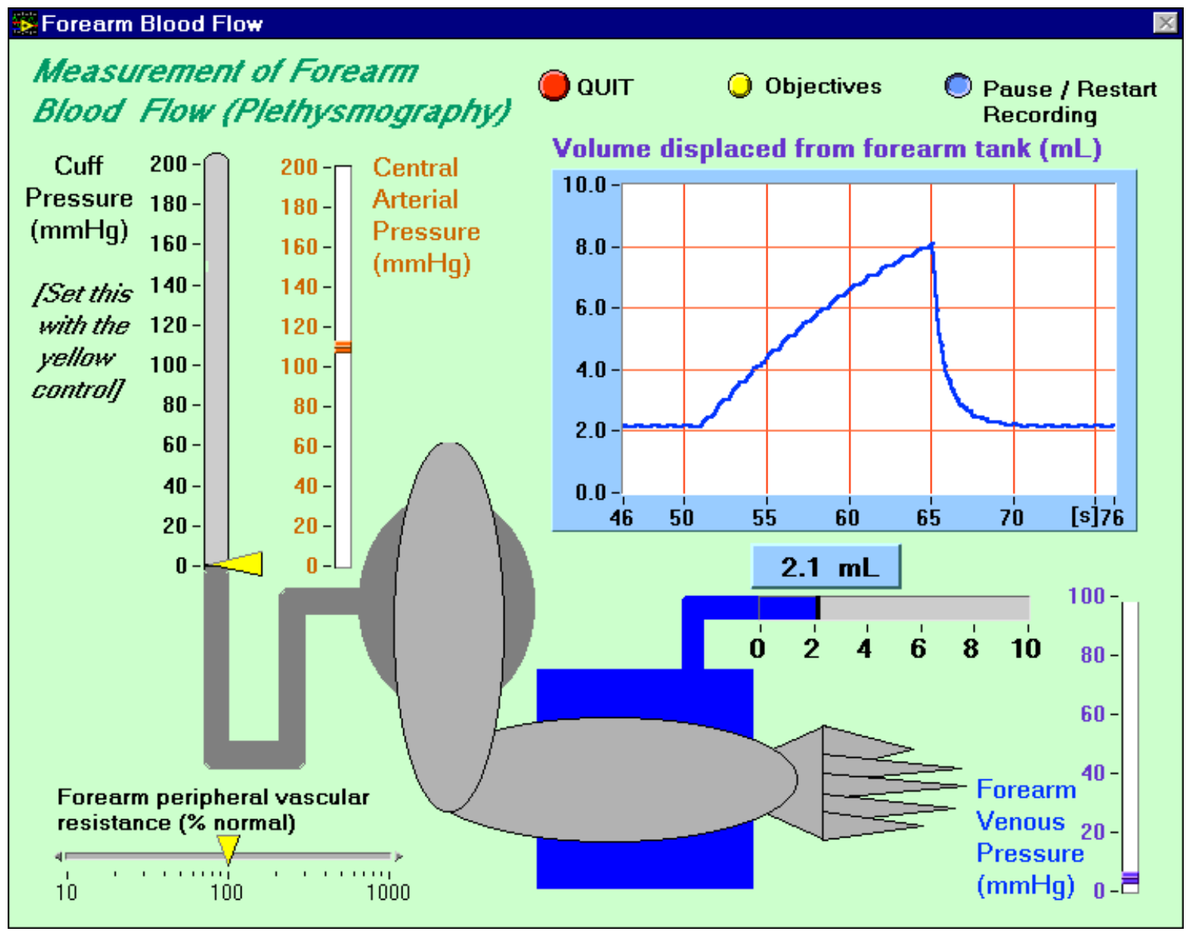
- **It rewards a student who correctly discriminates between sound answers and guesses, compared to one who gets the same proportion correct, but does not know which answers are reliable.**
- **It is closely related to -log(subjective probability for the correct answer). which is the proper measure of knowledge.**
- **It reduces the component of the variance of exam scores due to chance, associated with unconfident answers - thereby increasing the statistical efficiency of assessments.**

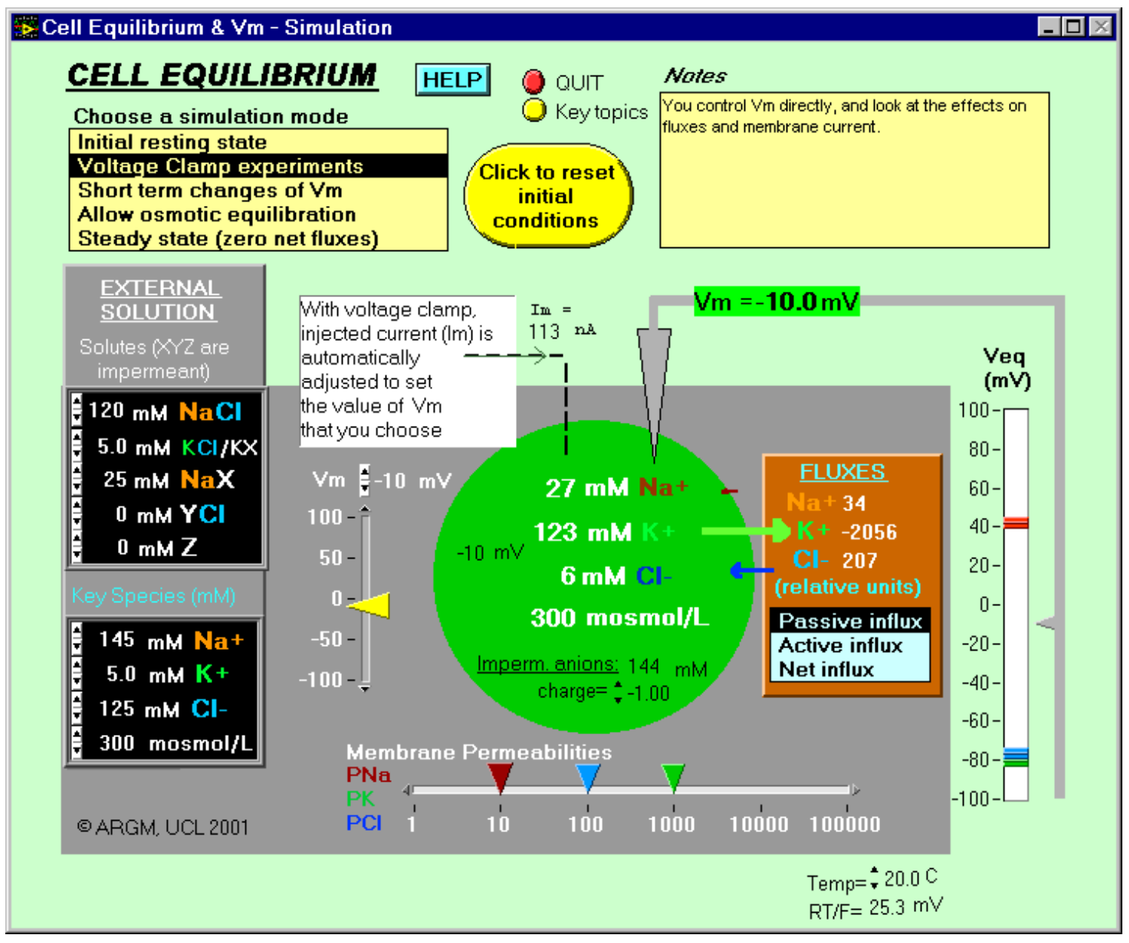


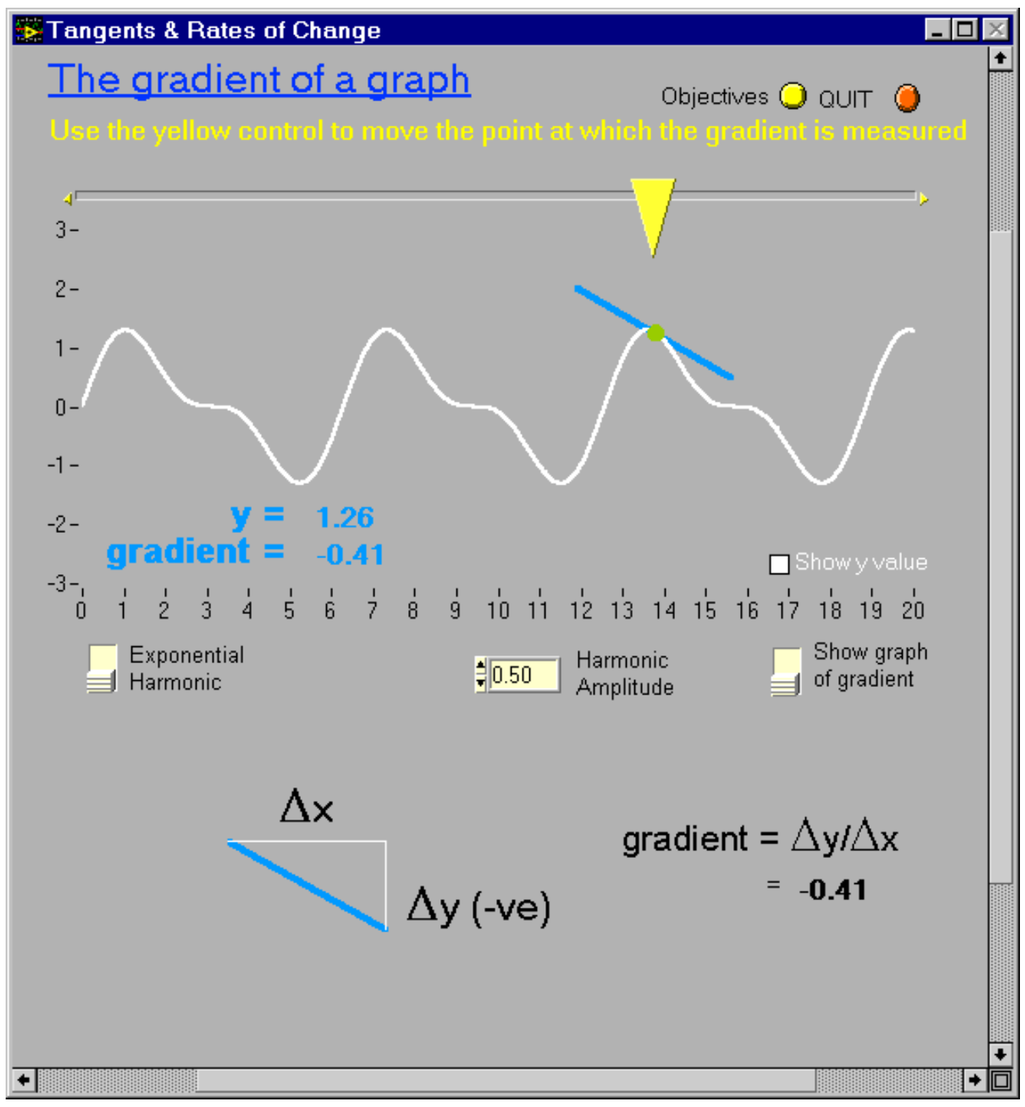
STIMULATING UNDERSTANDING AND VISUAL INTUITION

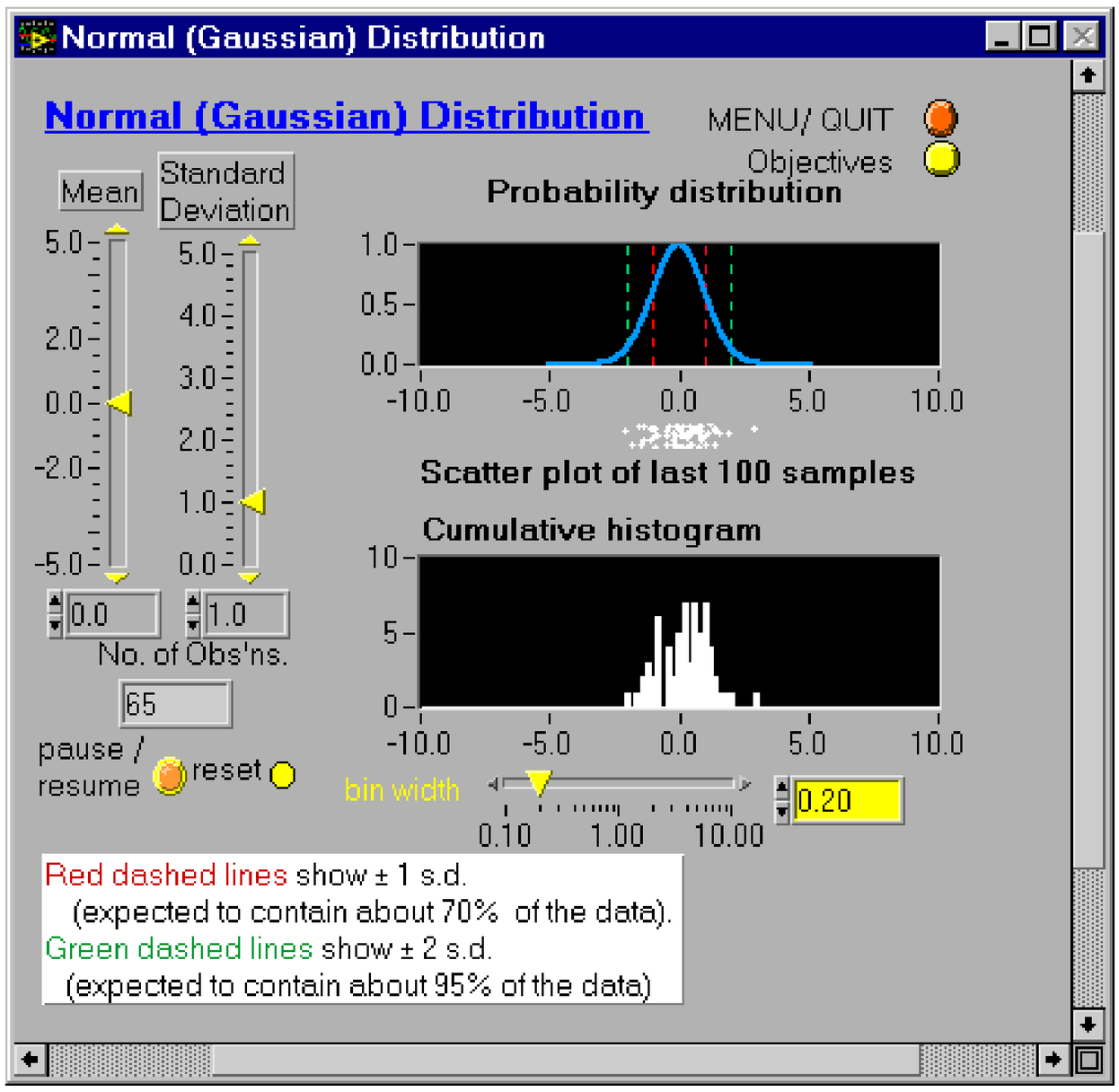
- Students often need to develop intuitive understanding about simple physical things in physiology like fluxes, currents, pressure and flow, and about statistical and graphical concepts like distributions, histograms, and rates of change.
- As scientists, we have usually built up mental pictures that aid such thinking, and we instinctively draw sketches to clarify ideas and aid discussion. *Students have seldom yet learned to do this.*
- Fast interactive programs like LABVIEW (*National instruments*) make it easy and quick to program interactive simulations to stimulate visual intuition.
- Students can see immediate smooth changes in the appearance of graphs and physical systems when they change parameters.
- Such active learning helps build the mental pictures that can be the foundation of clear thinking, and occasionally it dramatically makes concepts and inferences become self-evident.

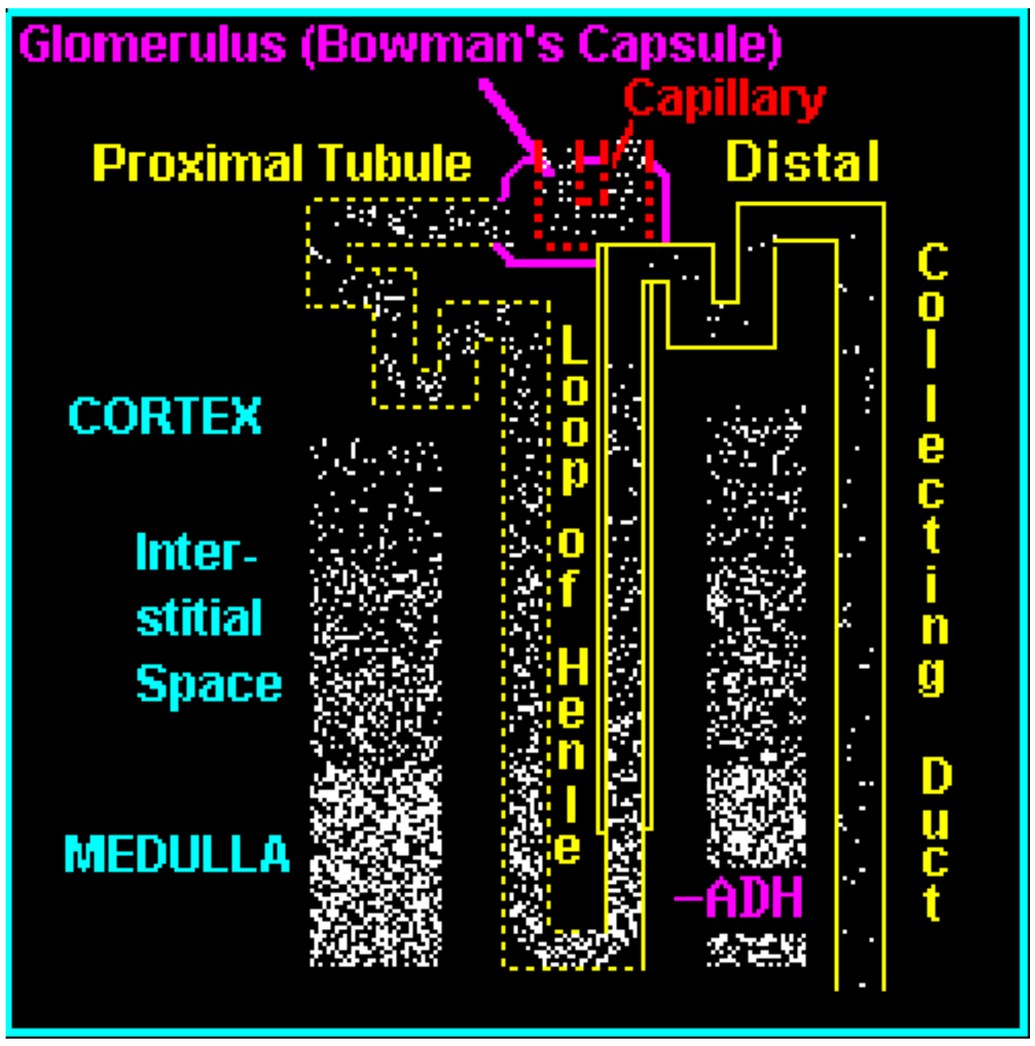
Some static pictures, lacking the fundamental interactive element, are shown below.

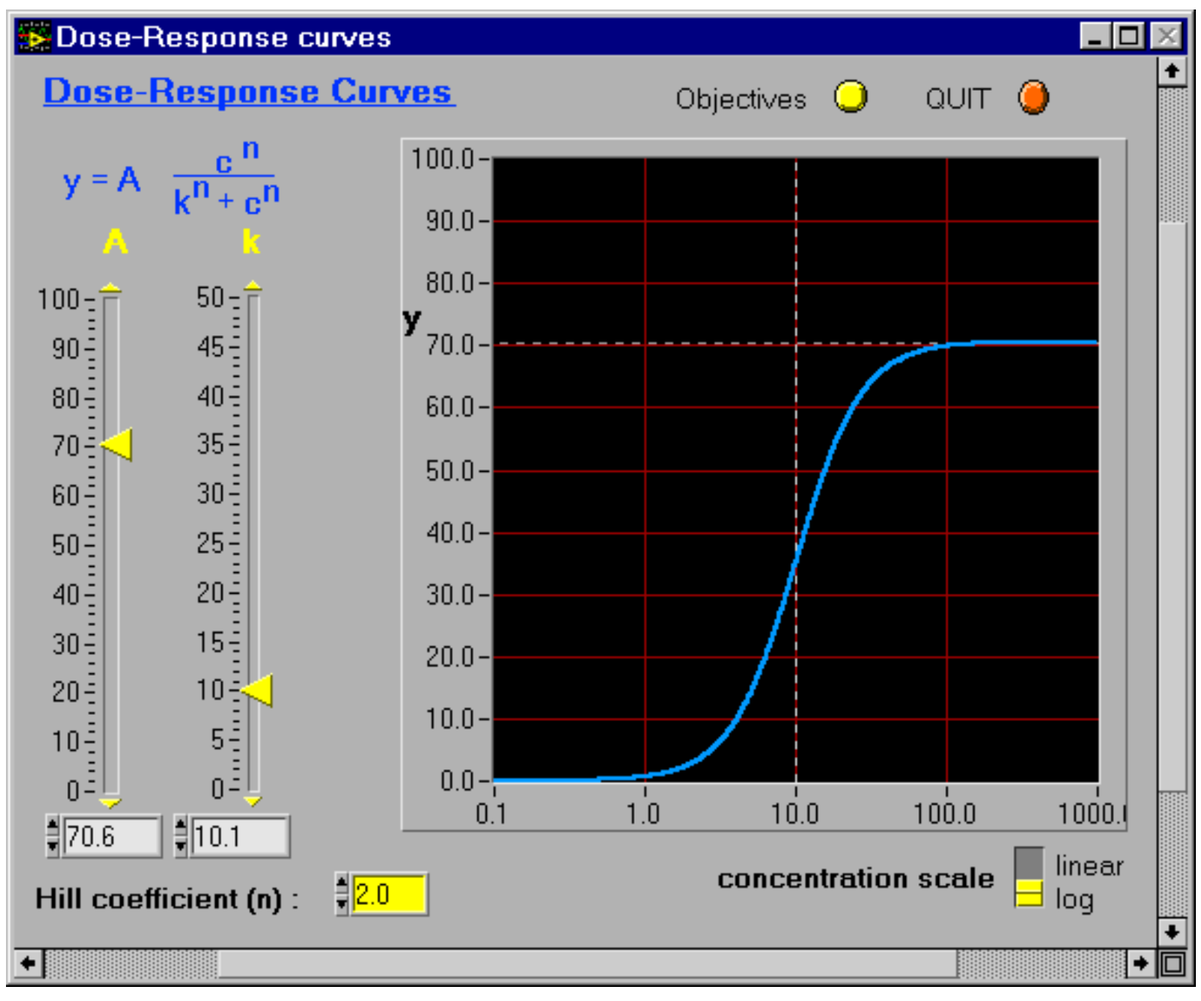












LAPT and LABVIEW exercises in use at UCL are available to those interested in collaborative development and exchange, from the LAPT web site (www.ucl.ac.uk/~cusplap).

Publications (some available at www.ucl.ac.uk/~ucgbarg

- Gardner-Medwin AR (1995) Confidence assessment in the teaching of basic science. Association for Learning Technology Journal. 3:80-85
- Gardner-Medwin AR & Curtin NA (1996) Confidence assessment in the teaching of Physiology. J.Physiol, 494:74P
- Gardner-Medwin AR (1998) Updating with Confidence: Do your students know what they don't know? Health Informatics 4:45-46
- Issroff K. & Gardner-Medwin AR (1998) Evaluation of confidence assessment within optional coursework.. In : Oliver, M. (Ed) Innovation in the Evaluation of Learning Technology, Univ. North London: London. ISBN 1-85377-256-9, pp 169-179
- Gardner-Medwin, AR (1999) Rational and irrational marking schemes. J. Physiol 515P: 48P
- Gardner-Medwin, AR (2000) Stimulating student understanding: a 3-pronged approach. Exp. Biol. Online. 5:S88