Pharmacology Experimental Benefits from the Use of Computer-Assisted Learning

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This paper was prompted by a recent increase in interest centered around education and training in Pharmacology which has been matched by developments of computer assisted learning (CAL) hardware and software. A well accepted problem of performing organ-bath tissue based pharmacology teaching in the pharmacy curriculum is the variability in tissue response and several factors complicate this issue. The aim of the study was to compare overall student perception of material taught using CAL with laboratory classes where there was poor to good tissue variability or where tissue preparations were already set up for student classes. Students found definite benefits from the use of CAL to supplement practical laboratory classes since there was a noticeable increase in understanding theoretical concepts in the applied setting of a real experiment.

INTRODUCTION

Recently, there has been a sharp increase in interest centered around education and training in pharmacology(1-6), although computer-assisted learning (CAL) has had relatively limited role over the last decade. However, the latter three years have witnessed the appearance of widely available hardware and software which has facilitated the development of presentations approaching the sophistication previously created by professional software houses or advertising agencies(7).

In particular, icon-driven authoring languages such as Authorware (Macromedia), Toolbook and HyperCard are well-suited for the preparation of CAL packages and yield convincing simulations which are attractive to students(8,9). This has made CAL more realistically available to educational establishments since packages can be produced with relatively little effort in house(10).

In this Department, the use of CAL software incorporating video, sound and animated graphics to replace animal tissue based (organ bath) practicals was first proposed in January 1992. In the intervening period, five ‘wet’ practicals previously undertaken by first and second year students have been replaced by computer simulations. In addition, there has been a gradual uptake in CAL relating to additional areas of the pharmacy course prepared by other members of the Pharmacy Consortium for Computer Aided
Learning (PCCAL) in the UK. Figure 1 provides a summary of the software which is either currently available or will become available from PCCAL in the 1994-1995 session

BACKGROUND

Preliminary studies indicate that the introduction of multimedia CAL is popular with undergraduates(7) and that the appreciation of the programs is not influenced by any previous computer experience(11) nor by a predominance of a mathematical or biological background prior to the tertiary education level. Moreover, there was a high rank correlation between assessment of student performance by computer and traditional appraisal by written examination(11). Even more complex three dimensional drawings and animations have been incorporated in more recent teaching packages using 3D Studio (Autodesk) and this further enhances the visual impact of CAL as a teaching vehicle(12). The replacement of pharmacology practical classes is a course of action which has generated some debate recently(13,14). In some schools of pharmacy, simulations are now used exclusively. In this context, the Welsh School of Pharmacy has replaced and/or supplemented 75 percent of its original practical classes in the first year of the course. Simulations are used to demonstrate pharmacological principles which are subsequently applied in those practicals which have been retained. Table I provides a resume of CAL usage by undergraduate students in 1993-1994 and this represents the first year in which complete hardware and software facilities were available.

AIMS OF THIS STUDY

Earlier studies suggest that some students prefer classical laboratory based practicals to CAL simulations and vice versa(7, 11) so an investigation was implemented in order to establish if any factors influenced the attitudes of students. A well accepted problem of performing tissue based experiments is the variability in tissue response. The influence of variability becomes accentuated by several factors including: (i) inherent inter- and intra-tissue biovariation which is unavoidable; (ii) the need to complete an assigned task in a relatively restricted period timetabled as a practical class (usually three hours); and (iii) the inexperience and initial lack of competence associated with early learning phases for all undergraduate students.

Tissue variability is at least partially determined by the speed with which the preparation is established in the organ bath environment, an area of capability in which experience or familiarity and expertise is critical. If the novice permits the tissue to become deoxygenated, allows it to dry out of bathing fluid or it is incorrectly handled (i.e., stretched excessively), then the results will inevitably be poor and lacking in validity. In short, practicals executed by a relative beginner may produce disappointingly poor results on a regular basis. Moreover, if positive results are not forthcoming, practicals are then soon viewed as unsuccessful and this

<table>
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<th>Year</th>
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<th>Private study (h)</th>
<th>Total</th>
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<th>Time per package (h)</th>
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may be detrimental to subsequent student motivation. Hence the aim of the present investigation was to compare overall student perception of material taught using CAL with laboratory classes where there was either poor to good tissue variability or where this factor had been nullified by the fact that preparations were already set up for the students and variability was of an intermediate nature.

METHODS
During the laboratory practical work and CAL sessions in this investigation, two academic teaching staff and two technicians were available for instruction and assistance of students at all times throughout. The students were first allowed to become familiarized with the computers for at least one session beforehand in order that they might spend all their time on the simulations during the actual CAL periods. They were then assigned to four groups (a total 99 pharmacy and neuroscience students in all). All groups were given a normal timetabled period of one and a half hours to complete the program on “Isolated Guinea Pig Ileum”. This interactive animated program not only examined the theory underlying potency (affinity) and spasmodenic activity (intrinsic activity) of choline ester agonists at cholinergic muscarinic receptors in the ileum (Figure 2), but also permitted students to view the set-up (Figure 3) and add a series of doses of these agonist compounds (Figure 4). They then recorded simulated contractile responses and plotted log concentration-response relationships in comparative graphic form (Figure 4) to gain an insight into structure activity relationships.

Having completed the computer programs, students then performed the three-hour practical laboratory class two weeks later, using real tissue preparations and covering the same format and theoretical material. Three of the groups set up tissue preparations for themselves and the fourth group had ready pre-set tissues prepared by the technical staff. During the course of practical classes, academic staff evaluated the reproducibility of results derived from preparations set up by each group as “good,” “medium,” or “poor.”

The student response was assessed by means of a questionnaire distributed immediately after completion of the
STUDENT RESPONSE

The general impressions gained from students regarding both the computer simulation and the actual laboratory practical were good. The overall view was expressed that they found the two exercises not only interesting but also educationally beneficial. It can be seen from the questionnaire results in Figure 5, that in answer to the first question, there was no distinguishable opinion as to the usefulness of the simulation towards the practicalities of setting up the experiment. Moreover, this conviction was not markedly derived feedback on the sequencing of such a combination. Hence, for the fourth question, the ‘good reproducibility’ group had no opinion as to whether the laboratory practical as opposed to the computer simulation allowed them to learn more at their own pace, whereas the group who experienced ‘poor reproducibility’ disagreed with this statement. It was interesting that for the ‘pre-set preparation’ group, there was also a similar disagreement with this statement. A possible conclusion that might be drawn from this finding would be that biovariation, rather than lack of student proficiency, had a more predominant contribution towards poor experimental reproducibility sequelae in teaching experiments of this type.

In the fifth question, student responses (i.e., disagreement with the statement that they would have preferred doing the experiment before the computer simulation) suggested that all designated groups were consistently in favor of prior exposure to CAL irrespective of the degree of success in the outcome of the laboratory practical.

DISCUSSION

CAL may play an important role in any instructional situation, whether practical or theoretical. It has the qualitative and quantitative potential to raise teaching standards to new levels of sophistication and it invariably proves cost effective especially when time is limited and equipment is in short supply(15).

In this study, there were definite benefits to students arising from the use of CAL as a supplement to practical
laboratory classes. This was reflected by a discernible increase in understanding which proved to be advantageous when theoretical concepts were utilized in the applied setting of a real experiment and subsequently, when appropriate data handling was required for results evaluation.

Where reproducibility of biological experiments is often compromised, student perception of their own rate of learning deteriorates and this inevitably has an adverse impact on motivation. It is precisely this kind of educational scenario where supplementary CAL would be most beneficial, allowing students to achieve a greater underlying depth of theoretical understanding such that during experiments, appreciation of practical problems would not be viewed as a negative exercise.

Both CAL and laboratory practical classes are valuable tools for education in biomedical disciplines like the pharmaceutical sciences(13). The role of computer simulation however, should not be to totally replace ‘hands-on’ experiments in the laboratory, but to provide students with the opportunity to be exposed to variables in a different medium to those experienced in a real experiment. The value of such an approach can only be augmented by manipulation of simulated variables in order to generate numerical or graphic data coupled with active mental and/or written formulation of concepts and hypotheses on the part of students(16-18). In any event, it is important that the emphasis does not swing overwhelmingly in favor of replacing traditional practical classes with CAL exercises(14). It is therefore essential that the merits of both forms of teaching are considered and that a balance is struck in the armory of the educationalist. This can only be to the advantage of students receiving such equity.

All the software used in the classes for simulations, and many other types can be obtained from: The Pharmacy Consortium for Computer Assisted Learning, University of Bath, Claverton Down, Bath, BA2 7AY, UK.

References