COMPUTER ASSISTED VIDEO INSTRUCTION (CAVI) IN AN ANESTHESIA TRAINING PROGRAM

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Abstract

For over 20 years advocates of computer assisted instruction (CAI) have been proclaiming impending revolutionary developments in the educational process, yet progress in acceptance has been slow. This paper will examine the advantages and weaknesses of CAI, and discuss the new concept of computer assisted video instruction (CAVI) in terms of its principles and application within our department of anesthesia.

Introduction

Since the early 1960's, a limited but vocal group of medical educators have been intrigued by the possibilities inherent in the application of computers to medical education. Some of the strengths of computer assisted instruction (CAI) include a non-threatening learning environment, permitting experience to be gained in a wide variety of clinical situations without endangering patient safety. With appropriate and timely feedback, misconceptions in the decision making process can be identified and corrected. Learning can take place at times convenient to the user, and the ability or enthusiasm of the instructor ceases to be a factor.

With the advent of microcomputers and the development of authoring languages and authoring systems (the former being no more than a specific language particularly suitable to developing a lesson with an interactive format; the latter is a structured self prompting English language program that guides an author in the construction of a lesson), an increasing number of educators are reporting the successful application of CAI in medical education, self-assessment and peer review. Despite this recent burst of enthusiasm, much skepticism exists among educators as to the true place of CAI in a medical curriculum. It is appropriate to ask why this is so.

Problems Inherent in CAI

Existing prejudices against CAI are reinforced by poor-quality courseware. Early systems were no more than electronic "page turners." Even today courseware is seldom constructed in a manner that makes use of the potential of the computer to quickly ascertain what a student knows and does not know, present appropriate educational material, and provide rapid feedback. Instead much of the existing courseware provides dull, routine drill-and-practice programs with a stereotyped feedback that creates a predisposition to the development of response sets. Other problems can arise when the author of the courseware attempts to avoid the Multiple Choice Questions (MCQ) format, and instead, asks the student for management decisions in a manner that requires free text entry, the handling of which by the computer is often primitive. Few programs provide for adequate syntactical analysis, and the response of the computer will depend upon its ability to recognize a "keyword" entered by the student into the text. Failure to provide the keyword, perhaps because it does not exist in the student vocabulary, results in a frustrating experience.

The vocabulary problem has in turn been addressed by providing long lists of signs, symptoms, laboratory tests, diagnoses and treatments from which sequential choices are made to construct a management scenario. However the authors plan of management may not accord with a different, but equally satisfactory, plan being constructed by the student. Finding the particular hidden sequence path preferred by the author may be a lengthy, frustrating and tedious experience. Other problems in this type of presentation are that the menu tends to impose upon the student an artificial structure to problem solving that lacks spontaneity, and interaction tends to be stylized in a manner that imparts none of the realities of the clinical situation.

As the informed author attempts to address the various factors in utilizing the computers full potential, the problem of the cost of courseware development becomes important. In a report on "Computer Technology in Medical Education and Assessment" (1979)1 Ohio State University College of Medicine has identified the amount of course development time needed for lesson construction. Total development time ranged, depending upon the complexity of the lesson structure, from 50 to 330 hrs/hr of terminal interaction time!

McIntyre has frequently and appropriately warned that reduction of the time spent with clinicians in the clinical milieu in favor of time devoted to CAI is not necessarily in the students best interest, since discussion with a skilled clinician in the working environment and experiencing social interactions with patients, nursing staff and other medical staff, can never be satisfactorily duplicated by CAI.

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Development of a Computer Assisted Video Instruction (CAVI) System

Being aware of these deficiencies, we attempted to establish reasonable guidelines and goals for a CAVI system as summarized in Table 1.

Desirable Features of CAVI System
1. Limited and specific instructional objectives.
2. Incorporation of a video dimension in the CAVI system.
3. Local lesson production capability.
4. Hardware components to be in common usage.
5. The authoring system must be acceptable to novice authors.
6. Limited system capital and lesson production cost.
7. Incorporation of a reliable, frame specific computer-video interface card.
8. Production time to be less than 40 hrs./hr. of interactive lesson time.

Establishment of Goals

In establishing this system specification it was decided to use CAVI specifically to prepare the student for, and reinforce specific clinical anesthetic experiences. To that end we chose to utilize the relatively new technique of computer assisted video instruction (CAVI) to attain the educational objectives of imparting knowledge, comprehension and application. It was felt that by using CAVI for these purposes all residents and students could be guaranteed exposure to a defined range of clinical anesthetic situations, thus avoiding the unstructured and erratic element of chance in determining the clinical experience of participants in our training program. By providing interactive decision making, it was hoped, through good courseware design, to allow the student to expose his cognitive decision making processes and by providing immediate feedback, apply remedial instruction where errors were detected. By utilizing this technique before actual exposure to the specific clinical situation, the student would be better prepared and thus able to comprehend and profit from the educational experience of the clinical situation. Likewise the CAVI presentation after the event would enhance and reinforce the attainment of the educational objectives. The established ability of the computer to impart knowledge combined with the demonstration, by example, of the application of that knowledge by a skilled clinician was expected to result in an enhanced learning experience for the student or resident.

The addition of the video component was considered mandatory for any new CAVI project. Video sequences in color impart a dimension of clinical reality which can never be achieved in a standard CAI lesson structure. Even in such an obtuse area as complex and ill-defined biological reactions, the addition of computer generated graphics incorporating motion and color can enhance comprehension in a way that alphanumeric data can never achieve.

Network Versus Locally Developed Systems

The existing nationwide network systems of CAI was initiated in 1972. Two of the most successful systems are the PLATO System marketed by Control Data and the Health Education Network System which permits access to computer-based educational materials at Massachusetts General Hospital (MGH) and the Ohio State University College of Medicine. A reasonably wide range of field-tested programs are available, but few relate to anesthesia and even if a wide range of programs were available, usage of the MGH system at the rate of only 20 hours/week would create an annual user charge of almost $13,000. Were this to be purely a department expense it would obviously be a significant budgetary factor. For these reasons it was decided to develop a departmentally produced CAVI lesson structure.

Hardware for CAVI Lessons

With the declining cost of microcomputers and the development of devices to allow them to interface with a videocassette recorder (VCR) or a laser optical videodisk (LOVD), the future of CAVI seems likely to be dominated by these two vehicles. Of the two the LOVD is the more satisfactory from a student's viewpoint. The mean access time to any one of the 54,000 frames of educational material on each side of a videodisk is less than 2 seconds, and the picture quality, particularly in the "still-frame" operating mode, is superior to videotape. However, from a lesson construction point of view, there are some advantages to utilizing videotapes and we have adopted techniques to minimize its deficiencies. Mastering a disk costs in the order of $1,500 and the information is permanent - it can only be updated or new material inserted by complete remanufacture of the disk. Obviously the videotape has great advantages in these two areas, and because of its relatively low production cost, formative evaluation of lessons can be undertaken with ease. By carefully constructing lessons to present material in a sequential fashion or recording previously presented frame sequences where a lesson architecture might require repeating previously presented material, it is possible to keep most searches of videotape to less than 20 seconds. Once a number of videotape lessons have been prepared that have demonstrated their effectiveness, it is possible to convert them to videodisk format, particularly if widespread marketing is envisaged since replication costs are much lower for a videodisk. It is, moreover, quite possible to combine videocassettes and videodisks within the lesson structure. The Allen Communication Universal Video Controller permits control of two VCR's, 2 LOVD's or one of each. Thus material that is presented sequentially or subject to frequent revision and change could be presented on the VCR, and material that is accessed in a random manner or unlikely to change is presented on the LOVD.

Because the components in a CAVI system are fairly sensitive, complex electronic devices, it was decided to establish two areas for their
permanent installation. The first area was designated an authoring station, and the second area (a user station) was established within our department's learning resources center, to which students and residents have access 24 hours/day. Security for the hardware and software was achieved by placing it within an Allen Communication Learning Station. This is an attractive self-contained ergonomically designed cabinet and work area which enables all components to be locked and secured. The entire system can be functional and fully ventilated with the user able to see the color monitor screen and access nothing but the keyboard.

Features of Authoring Systems

In order to facilitate authoring ease and reduce the length of time required to produce lessons, it was decided to make use of an authoring system. An authoring system manages the process of creating courseware but in programs like standard format on lesson construction and, to some extent, reduces the ability of a skilled interested author to generate truly innovative and flexible lessons. However, the convenience of a simple, fully prompted, computer generated lesson structure appeals to most people. The choice of an authoring system will then usually dictate the choice of an interface card, which will in turn dictate the choice of all other hardware components. In deciding upon an authoring system, all aspects of the complete systems efficiency, convenience, universality and cost must be examined. Authoring systems are offered by BCD Associates, CAUS Systems, Bell and Howell, Whitney Educational Systems and WICAT Systems among others.

Characteristics of successful authoring software are set out in Table 2.

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<tr>
<th>Table 2</th>
<th>Characteristics of Successful Courseware Authoring Systems</th>
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<tr>
<td>1.</td>
<td>Flexible lesson structure.</td>
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<td>2.</td>
<td>Lesson exhibit consistent response times.</td>
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<td>3.</td>
<td>Appropriate feedback responses can be developed for each MCQ.</td>
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<td>4.</td>
<td>The lesson objective can be presented as a series of discrete goals.</td>
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<td>5.</td>
<td>User determined choice of presentation of the individual lesson components.</td>
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<td>6.</td>
<td>Ability to provide a termination summary.</td>
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<tr>
<td>7.</td>
<td>On-line user performance statistics are maintained.</td>
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Ideally authoring software should permit as wide a diversification of lesson structure as possible. This capacity reaches its limits in programs like the one reported to have been developed at the Xerox Corporation's Palo Alto Research Laboratory in which a students answers are analyzed for patterns of errors that will identify faulty concepts of cognitive reasoning, and then, feedback is provided to correct these faulty concepts. Another example of sophisticated lesson structure is the CASE system where students proceed from the initial patient description to the final diagnosis and treatment by utilizing entirely their own style of interrogation, investigation and treatment.

However, such complicated lessons are beyond the scope of commonly available authoring software, and the usual model is a branched tree structure where each branch provides a decision point at which a question is presented that requires a multiple choice or free text input. The inability of the student to type the interactive response required is to simply choose between computer presented answer alternatives. Such responses also simplify construction by alleviating the need for syntactical analysis of input such as blanks, mixtures of upper and lower case, misspellings and wrong letters.

Studies have shown that it is not so much the length of system response time that is upsetting to students, but extreme variability. Our system has demonstrated the ability to limit response times to a consistent 15 to 20 seconds. The standard response text of "correct" or "incorrect" or tedious repetitive rewards are undesirable and can lead to response set formation which is the development of a pattern of responses that are inappropriate or illogical. Remedial text should be provided for each wrong answer and reinforcement text for each correct one, since a correct answer in a MCQ can always be arrived at by guessing. To prevent frustration two successive incorrect answers to the same MCQ should prompt some corrective action on the part of the computer either by representing some previously presented instructional text or clinical sequence, or by displaying the text associated with the correct answer and then proceeding to the next question. More than a certain number of incorrect answers in a series designed to teach a particular objective should cause the computer program to move on to another segment of the lesson addressing a different objective, while advising the student to seek remedial help relating to the failed segment from a specifically designated instructor.

Boredom is also a significant factor that must be addressed through good system design, perhaps by providing an abbreviated lesson pathway for those students who consistently generate correct answers. Learning will be enhanced if the material being presented is divided into discreet units thus giving the student intermediate goals that can be obtained on the way to mastering the overall concept being presented.

Versatility in presentation of the instructional material is desirable since students will make different demands upon the system at different times. This usually takes the form of the ability to view individually or in various user-determined combinations, the components of the lesson structure, namely instructional text, clinical sequences or MCQ's.

Various interrupt modes should exist within the operating system. Where a number of MCQ's form a series, the capability of reviewing previously presented material should exist. Other "user friendly" features such as continuous on-screen user prompts, an escape key to a "help" menu, and protection against system "lock-up" due to inapp
appropriate commands should all exist within the system. The ability to skip questions and return to them later, to review all answers and modify them or to suspend the program and return to it at a later time will all enhance the learning process. It is also desirable that there exist the ability to present a summary of the lesson content and its objectives at the conclusion of the lesson. Educational psychology has clearly demonstrated increased retention when factual presentation and practice is distributed over time.

Online generation, storage and presentation of statistics is a most important feature. Each student's performance statistics should be made available if he or she so desires, and statistical reports to the instructors should include the percent of incorrect responses to each question. In this way areas of didactic teaching that require revision can be identified and strengthened, and the system can be fine tuned to eliminate ambiguous or unsatisfactory questions.

The components we have used are an Apple IIe computer and one disk drive, a BCD 400 interface card and BCD "Instructor 3.0" authoring system, Amdek Color-1 monitor, Panasonic NV 8200 industrial quality VCR and Epson 100 F/T printer. We have now used this integrated system to construct a number of CAVI lessons and basically the authoring procedure is as set out in Table 3.

Construction of a CAVI Lesson

<table>
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<tr>
<th>Step</th>
<th>Description</th>
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<tr>
<td>1.</td>
<td>Director of Audio-Visual and Medical Education Coordination</td>
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<tr>
<td>2.</td>
<td>Test script is prepared.</td>
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<tr>
<td>3.</td>
<td>Time of visual sequences</td>
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<tr>
<td>4.</td>
<td>File is edited and title requirements targeted.</td>
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<tr>
<td>5.</td>
<td>Instructional text is prepared and MBA checked.</td>
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<tr>
<td>6.</td>
<td>Final version begins database or manuscript.</td>
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<tr>
<td>7.</td>
<td>Medical Education Coordinator</td>
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<tr>
<td>8.</td>
<td>Construction of script and computer compatibility.</td>
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<tr>
<td>9.</td>
<td>Programming of test and test system using the computer's Authoring system.</td>
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<tr>
<td>10.</td>
<td>Output from a panel of instructions and a small test group of students.</td>
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<tr>
<td>11.</td>
<td>Evaluation and modification.</td>
</tr>
<tr>
<td>12.</td>
<td>Release of desired product.</td>
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Multiple choice questions (MCQ) are utilized as the sole method of student interrogation, and a data base of such questions has been created utilizing the university mainframe computer. Each question's stem, alternatives and distractors are examined for appropriate construction and then field tested with performance of item analysis including discrimination index before being finally accepted into our data base.

Conclusion

Assessment of the efficacy of our system has, to date, been purely subjective. The impression of our sub-specialty instructors is that students and residents are better prepared and more rapidly develop competency in the areas in which they have been exposed to this lesson system. Certainly the system has been received with enthusiasm by students and residents. However, the future success of CAVI is not only dependent upon the factors that have been outlined but on being able to interchange lessons with those developed by other sources. Unfortunately, there is little hope for CAVI hardware and software standardization at this point in time, although the Apple II computer does seem to be the most popular microcomputer for medical education purposes. The development of sophisticated programs making use of the computer's full potential will only be cost-effective when a large potential market exists. Standardization will provide that market.

It should be emphasized that this instructional tool is not used as a substitute for other teaching methods but as a supplement to those methods. The success that it has enjoyed, we believe, results from factors that were summarized by Kearsley and Hillelsohn7 namely that "to the extent that the courseware is interesting and meaningful, the equipment is reliable, and the student receives timely feedback on progress, learning will be the easiest route."

REFERENCES