SECTION V

APPLICATION OF INFORMATION TECHNOLOGIES TO THERAPEUTIC DECISION MAKING

COMPUTER-ASSISTED INSTRUCTION IN CLASSROOM AND LABORATORY MILIEUS

Craig Marcus
Dept. of Pharmacology and Toxicology,
Health Sciences Center, College of Pharmacy,
University of New Mexico
Albuquerque NM 87131

Higher-order biological processes in living organisms are dynamic, complex processes requiring the simultaneous integration of multiple independent steps in various cells and organs and tissues. As such, these processes are difficult for students to conceptualize, and likewise present a substantial challenge to the instructor in both the classroom or laboratory milieu. Traditional approaches to teaching these concepts are frequently inadequate, and rely on didactic presentations accompanied by drawings of sequential static diagrams on blackboards or overhead projectors, confusingly annotated with numerous arrows and hand-waving explanations. These instructional efforts frequently fall far short of adequately conveying a comprehension of such complicated concepts and processes. Vastly more effective dynamic illustrations, either via cinematic or video cartoons or actual working models were previously too expensive or time consuming for the average instructor to prepare and employ for routine use. The general approach widely utilized in the life sciences has been to supplement didactic lectures with laboratory exercises utilizing living systems (usually live animals) to further demonstrate these principles and reinforce concepts presented in the classroom. However, complex biological processes are not always readily modeled with simpler, in vitro systems, such as ethically more acceptable isolated cells or cell homogenates. Therefore, animal experimentation still often has served an essential function in the educational process for students in the life and health sciences. Unfortunately, effectively demonstrating complex biological process utilizing live animals can itself be as technically challenging to the instructor as the understanding of such processes is to the students. There are a number of constraints on these type of demonstrations, including: 1) the time involved in the experiments and the preparations, 2) the cost of the experiments, 3) the limited number of experiments/demonstrations that can be conducted, 4) the wide range of inter individual variation in responses that is to be expected from any population of organisms, and 5) the objections to utilizing live animals for instruction. No matter how carefully experiments or demonstrations with live animals are conducted, they will not all be successful, nor clearly illustrate the processes of interest.

Computers and computer video projection displays are now increasingly available in the classroom. Hence, computer-generated demonstrations incorporating high definition animations and real life video imagery may now be routinely incorporated into lecture presentations, as readily as slides or overhead transparencies. Likewise, computer-assisted simulations can in many cases be substituted for laboratory exercises using live animals. As a result of rapidly evolving computer technology, it is no longer required that students be extraordinarily proficient in the use of computers to utilize such learning exercises. This has been made possible via the development of consistent and intuitive user interfaces and development of topic-specific learning exercises. Furthermore, instructors also need no longer need be experts in computer programming to develop such instructional materials, due to the wide availability of affordable new software applications designed specifically for the creation of instructional software. Utilizing these new software applications, even only moderately "computer-literate" instructors can develop sophisticated microcomputer-assisted instructional materials that can run even on entry level Windows or Apple computers.

A major advantage of these new software applications is that once developed by the instructor, they require no additional specialized software on each individual host (student) computers to be executed. Fully functional "stand-alone" applications may be created and reproduced freely with no need for end users to purchase the development software or for additional licensing fees to the distributors of the software development tool vendors. A number of suitable software packages are currently commercially available for developing computer-aided instructional modules. For example, we have utilized primarily (but not exclusively) those from MacroMedia Inc., in part due to their ability to produce applications for both the Windows and Apple computer platforms, and the lack of licensing fees for individual applications once created with the software.

Instructional materials developed to date fall into three categories: 1) detailed animations of complex biological processes employed in the classroom as an adjunct to didactic lecture material; 2) simulations and problem solving laboratory exercises, replacing exercises utilizing live animals; 3) stand-alone instructional, tutorial and problem-solving modules available to the individual student outside of the lecture format, as a mechanism for review of concepts presented in lecture and for self-evaluation of their comprehension. It is important to recognize the computer-assisted learning exercises described herein are intended not as replacements for traditional lecture presentations and laboratory exercises, but to augment and enhance the learning process by providing improved animated visual representations of complex processes, and more rigorous problem-solving learning exercises for the student. It is to be further emphasized that computer-assisted learning exercises are not merely an empty display of technological glitz, but can clearly represent innovative developments in the instructional process. Such computer-assisted learning modules can vastly improve not only the efficiency but also the efficacy of the learning process for a large number of students in health and life science-related fields.

Major applications developed and currently utilized by the author include a computer-assisted laboratory exercise simulating the pharmacokinetics of drug metabolism in a laboratory rat as well as numerous animations of complex biological processes utilized as instructional aids in the lecture hall. The laboratory module, utilized by 175 students per semester has replaced a lab module previously requiring approximately 100 animals/semester. For this lab, each student works independently on a computer workstation to complete the instructional and problem-solving exercise. A key feature of these laboratory exercises is the capacity for students to interact in real-time with the simulation, alter experimental parameters and immediately observe and quantitate the results of changes in the experiment. Other instructional modules are utilized as supplements to lecture material. Students view these animations and demonstrations during classroom lectures, projected as images of size and clarity comparable to those from 35 mm slides. Additionally, students may review the materials at their convenience in campus instructional computer labs, or from home with commonly available personal computers. Outcomes for implementation of the described learning exercises has been favorable in several respects. Student interest in such learning modules is generally high, and has resulted in greater student involvement and enjoyment of the learning process, with concomitant gains in student comprehension and conceptualization of key biophysical processes, and computer-assisted instructional modules can substantially facilitate incorporation of increased problem-solving and self-evaluation exercises into existing curricula.

MULTIMEDIA IN VETERINARY MEDICAL EDUCATION: ANALOG VIDEODISC TO DIGITAL VIDEO

Charles E. Branch, Ph.D.
213 Greene Hall
Auburn University, AL 36849

Several years ago we developed a videodisc-based program to present a visually realistic series of traditional dog labs in cardiovascular physiology (1, 2). That program is now commercially available.

Following that development we began seeking funding to help other schools create similar programs. Eventually faculty members from seven schools founded the CONVINCE consortium to encourage multimedia developments. CONVINCE obtained a grant from the Geraldine R. Dodge Foundation to support development. Over a three-year period CONVINCE used those funds to award 14 grants for development of videodisc and other multimedia programs. The grants were awarded based on written Requests For Proposals using a peer review committee.

More recently the work in our lab has focused on the use of digital video for instructional programming. This has involved evaluating of the tradeoffs, conducting tests of various digital video formats and vendors, and developing test programs with side-by-side comparison of the same video clips using traditional videodisc vs. MPEG digital video.

This paper will briefly describe all three of these efforts. The presentation will include samples of the cardiovascular lab videodisc and digital programs. Following the presentation there will be a hands-on session in which these programs, as well as some samples from the CONVINCE projects will be available for observation.

Cardiovascular Lab VideoDisc Program

Using real-time polygraph recordings of EKG, Blood Pressures, Blood Flow, and heart rate, the program illustrates catheterization of the heart, autonomic drugs, autonomic nerve stimulations, autonomic reflexes, positive pressure ventilation, manometer experiments, fibrillation and defibrillation. A window simultaneously illustrates the experimental procedures in real time during the recordings. The program also illustrates experimental preparation procedures (anesthetization, cutdowns, cannulations, etc.). Other programs illustrate the normal and abnormal cardiac cycle using animations on the videodisc.

The videodisc includes the experimental procedures, the polygraph recordings, two channels of audio, and video-based animations of the cardiac cycle and others. The computer programs control the hardware and control the branching. Computer text overlays the videodisc video, if a video overlay board is installed. The programs also will operate in a dual-monitor mode for those without an overlay board.

The authoring program, which we developed for this project, converts an outline-based ASCII text file into Microsoft QuickBasic 3.0 source code. A separate interpreter program reads this source code at runtime to present the lesson. Those who own QuickBasic 3.0 also may compile the programs to exe files.

We use a commercial outlining program to develop the lessons, but any word processor capable of generating ASCII files may be used.

The authoring program supports Videodisc Players, Random Access Slide Projectors, PCX SVGA Graphics, and various Video Overlay Boards. The authoring program is made available at no cost to users of the videodisc for the purpose of customizing the lessons or re-purposing the videodisc.

CONVINCE Consortium Projects:

The projects listed below were supported through a grant to CONVINCE from the Geraldine R. Dodge Foundation. Contact the investigator directly for more information on the availability of the programs. A brief summary of each project is given in the Appendix.

1. An Interactive Laser Videodisc and Educational Programs for Veterinary Ophthalmology and Comparative Ophthalmic Pathology
   Dr. Alan H. Brightman, Kansas State University
   Phone: 913-532-5690
2. Surgical Procedures in the Dog: Cranial Cruciate Ligament Repair
   Dr. Michael H. Sims, University of Tennessee
   Phone: 615-546-9230
3. Peripheral Neuroregulation Interactive Videodisc Course
   Dr. Clifford R. Swanson, North Carolina State University
   Phone: 919-829-4200
4. Clinical Anatomy of the Pig
   Dr. Phillip R. Garrett, Auburn University
   Phone: 205-844-4427
5. Surgical Anatomy in Small Animals
   Dr. Michael H. Sims, University of Tennessee
   Phone: 615-546-9230
6. Dairy Dilemmas
   Dr. Ken Nordlund, University of Wisconsin
   Phone: 608-263-8399; FAX: 608-263-6573
7. Bovine pregnancy: A Multi-Media Learning Module
   Dr. Alastair JS Summerlee, University of Guelph
   Phone: 519-823-8800 Ext. 4423
8. Development of an Interactive Video Program (Lamexam) for the Diagnosis of Lameness in the Horse
   Dr. Karl F. Bowman, North Carolina State University
   Phone: 919-829-4243
9. Surgical Techniques Auto-Tutorial Program III
   Dr. Sheila W. Allen, University of Georgia
   Phone: 404-542-6386
10. Diagnostic Approach to Hepatic Disease in the Dog with Clinical Case Studies
    Dr. Dennis B. DeNicola, Purdue University
    Phone (317) 494-7541; FAX (317) 494-9830
11. Development of Computer-Based Instructional Materials for Teaching Veterinary Dermatology
    Dr. James R. Snell, Texas A & M University
    Phone: (409) 845-3203; FAX (409) 847-8981
12. Diagnostic Imaging Simulation
    Dr. Pete Bill, Purdue University
    Phone: (317) 494-8636; FAX (317) 494-0781
13. Radiographic Techniques and Interpretation of Abdominal and Thoracic Disorders of Dogs and Cats
    Dr. Russell L. Tucker, Washington State University
    Phone: (509) 335-0711

Digital Cardiovascular Lab Program:

The CD ROM version of the program will be Windows-based instead of DOS-based. Polygraph recordings will be presented as digital images, with motion being simulated by an animated moving pointer. Digital audio files will replace the videodisc narration. Digital AVI-based animations will replace the videodisc animations. MPEG digital video files will replace the video motion for those with the appropriate hardware.

The new version of the authoring program is now Windows-based. It includes: Videodisc Player Support, WAV File Sound Support, BMP Graphics Support, AVI Animation Support, MPEG Digital Video Support, and Overlay Board Support (Both Videodisc and MPEG video). The source file is still created as an outline. The authoring program converts the outline into source code which can run in either the DOS environment of the Windows environment. The later is required in order to use Wav, AVI, or MPEG media.

MPEG Digital Video Tests: we have made MPEG conversions of representative video sections to evaluate which video sections will be most usable, and to evaluate which service bureau we might use for the final conversions. A test lesson includes sections from various portions of the existing videodisc program, but presents side-by-side comparisons of the videodisc clips and the different versions of the MPEG digital video clips. The presentation will include side-by-side comparisons of the videodisc clips with the MPEG clips done by the four service bureaus, as well as clips done in our own lab for comparison.

We would welcome comments, suggestions, or active collaboration with other educators interested in this project.

Digital Video Considerations:

During this process we have learned several things about converting analog video programs into digital. Some of this may be useful to others who are considering converting existing videodisc projects to digital video or creating new programs using digital video. These include some of the tradeoffs between quality a and still frame compression, motion video compression, and color reduction.

Today's Digital Video: The digital video available today on personal computers (AVI, QuickTime, etc.) is far below the quality expected by today's "TV Generation" of students. Even advanced digital video (e.g., MPEG1), is slightly below today's home VHS tape player in quality.

Conclusion #1: Digital video is best used today for selected small samples where extremely high resolution is not required, or where a small window can illustrate the important point of a video clip.

Still Frames: A standard CD ROM can hold about 650 MB of data. A single videodisc still frame at 704 x 480 x 24 bit (16 million colors) requires roughly 1 megabyte of storage. That would give us a limit of about 650 images on a single CD ROM. Images can be compressed to roughly 10% before most observers would notice a substantial loss in quality for typical images; that translates to about 6500 images. This is far short of a typical videodisc image collection, which may have as many as 54,000 high-quality images.

Conclusion #2: It is not feasible to convert videodisc stillframe image databases to a single CD ROM.

Motion: For motion video we can use an additional compression technique: interframe compression. If adjacent frames change little (e.g., talking heads), then we can get very high compression. The net result is that we may get as much as 1 hour of video on a CD ROM using MPEG1 compression, which is slightly lower in quality than a VHS tape played on a typical consumer grade player. MPEG 1 is 352 x 240 pixels (about 1/4 screen), but some hardware can interpolate the quarter screen to full screen with surprisingly high apparent quality.

Conclusion #3: It may be feasible to convert videodisc programs which consist primarily of motion video, provided that the motion video does not require very high resolution.

Future "Super CD ROM": By the end of this year it probably will be possible to purchase a new type of CD ROM video player which can play MPEG2 movies on a home television with much improved quality (quality which is similar to that of DirecTV satellite video). Some time later similar CD ROM players should be available for use with our computers. These CD ROMS will have as much as 17 GigaBytes of storage. That is still only a fraction of the 54 GB of an analog videodisc, but compression techniques will make it possible to include several hours of video. When that technology becomes widely available, then we may finally see digital video with as high a quality as that expected from today's TV generation.

Conclusion #4: Within the next two years it should be possible to use realistic video in our CAI lessons. It may take a little longer before it becomes economical.

References

1. Branch CE, Slimp M, Robertson BT et al: Interactive Videodisc Simulated Physiology Labs. Computers in Life Science Education, Vol. 6, Number 11, November, 1989.

2. Fawver AL, Branch CE, Trentham LA et al: A Comparison of Interactive Videodisc Instruction With Live Animal Laboratories. Amer. J. Physiology (Adv. Physiol. Educ) 4): S11-S14, 1990.