Developing a Multimedia Program that Emphasizes Applications of Functional Anatomy[1]

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Abstract

A multimedia compact disk (CD) program was designed and produced for the purpose of enhancing the mastery of anatomical and physiological concepts by undergraduate students in animal science and related agricultural sciences. A problem-oriented approach for the presentation of fundamental principles of functional anatomy in farm animals was used. Students are presented narrated video, text, graphics, and animation that are relative to the anatomy and physiology of the somatic portion of the peripheral nervous system in nine lessons. Mastery level of each of the lessons is assessed by twenty randomly selected multiple-choice questions from a 100-question bank.

Four real-life case studies of neurological abnormalities in the horse and cow are documented. Expert prompts, including history and details pertinent to each case, are provided in video and text format to aid the student in formulating initial observations. Upon successful completion of the lesson material and quiz, the students are expected to enter their own conclusions about the nature of the abnormality. This information, along with student's notes and quiz responses, are stored on a diskette and subsequently reviewed by the instructor. At the end of the program the expert gives a synopsis of the neuromuscular involvement in each case thus allowing the students to assess their own conclusions. This program underscores the practicality of understanding structural and functional relationships of the nervous and skeletal muscle systems that underlie commonly occurring neuromuscular abnormalities in farm animals.

Introduction

The Department of Animal Science at The University of Tennessee has an enrollment of approximately 300 undergraduate students, the majority of whom are required to successfully complete AS 220, a three semester-hour course entitled Anatomy and Physiology of Farm Animals. The course serves as a foundation of fundamental information on the structure and function of the major body systems of animals on which succeeding courses in animal science, wildlife, and veterinary medicine build. Inclusion of a course like AS 220 in curricula of general agricultural sciences, agricultural biology and natural resources is typical for universities worldwide.

Because of the large number of students enrolled in this course (average of 65 students/semester over the past five years), very few students are able to personally interact with instructors. Few students actually see dissections being performed and fail to gain a proper three-dimensional perspective of body parts. Communications with other institutions that offer similar courses indicate that these problems are common. In addition, approximately 66 percent of our Animal Science majors have expressed an interest in continuing their education in veterinary medicine or in post-baccalaureate graduate studies in animal science. A strong foundation course in functional anatomy of domestic animals is paramount in order for these students to master more advanced physiologic concepts taught at the professional or graduate level.

Computer mediated instruction has gained increased attention and popularity in the instruction of students in health related studies (Jensh, 1987; Clayton and Wilson, 1988). Educators in the health care sciences have recognized its potential in training professional students in practically all aspects of health care (Singarella et al., 1988). Multimedia computer programs have been particularly successful in medical applications because they reduce the time required to present lesson content, increase learner retention, reduce study time, and develop mastery of skills in a shorter period of time (Curless and Coover-Stone, 1987). Some students who have been exposed to these programs actually improve their problem-solving skills (Stevens et al., 1989).

Students in colleges of agriculture that are not required to practice operating at all four levels of

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cognition (e.g., remembering, processing, creating, and evaluating) are less likely to learn to create and evaluate on their own (Newcomb and Trefz, 1987; Whittington and Newcomb, 1990). This observation finds support in a survey involving approximately 1500 graduating seniors of universities offering undergraduate degree programs in agriculture. The results indicated that only 36 percent of the students felt they had achieved full competence in critical thinking, while twenty percent rated their competence as less than optimum (Love and Yoder, 1989). Increased levels of interaction between students and faculty could address this type of deficiency, but the student/faculty ratios will not allow this solution. Interactive multimedia CD programs, such as the one reported here, should prove to be an acceptable alternative.

The objective of this project was to design and produce an interactive CD-ROM program that would provide undergraduate students in agricultural science and natural resources with a self-paced, computer-enhanced delivery system for learning physiologic concepts and anatomic relationships in farm animals using a problem-oriented approach.

Materials and Methods

The project consisted of five stages, taking approximately two years to complete. The five stages were: (1) analysis and design, (2) development and production, (3) authoring and validation, (4) implementation and analysis, and (5) distribution. The authors served as the content experts whereas professional videographers, photographers, medical illustrators, graphic artists, programmers and production specialists were contracted to complete the production team.

Analysis and Design

The first six months of the project were devoted to analysis and design. Initially, a questionnaire was mailed to department heads or deans of all 1862 and 1890 land grant colleges and universities offering animal, dairy and/or poultry science curricula (n = 106) nationwide in an effort to construct a database of information related to the specific needs of undergraduate students enrolled in a farm animal anatomy and physiology course. Specific questions were designed to assess: 1) the enrollment, the frequency of course offerings, and course content, 2) the type of computer equipment that was available, 3) the need for multimedia support for certain body systems, and whether or not live or preserved specimens were used. The design of the CD-ROM is the documentation of how the CD-ROM program will function and respond to the student's input. Flowcharts were used to lay out the navigational design of lessons. The flow of each lesson was similar so students would know what to expect after the first lesson.

Also during this period, decisions were made about programming and hardware requirements. The authoring system that was selected was Authorware by Macromedia. This modestly priced program (academic version) can be used in an icon-based mode for non-programmers or in the program-language mode for more advanced programmers. We selected a hardware platform (PC) with a minimum of 200 MHz Pentium processor, Windows '95, 800 x 600 graphics at 24-bit depth, 4x CD-ROM drive, 360 MB disk space available, and floppy disk drive.

Development and Production

Approximately twelve months were used for developing lessons, writing explanations of case studies, acquiring the necessary video, composing questions for student evaluation, and completing artwork and graphics. Raw video footage was edited and narration was provided from carefully prepared scripts. Some of the audio and video clips were shot and edited by the Instructional Video division of Instructional Resources in the College of Veterinary Medicine. Some video as well as the layout and graphic design was the responsibility of the UT Center for Telecommunications and Video. Staff in Instructional Resources did the medical illustrations and some graphics.

Authoring and Validation

Authoring is the defining step in the production of the multimedia program. Thus, the majority of the second year was used for programming and post-production. This is the phase during which the programmer, using the Authorware software, combined the video, graphics, animation, audio, and text into a single program. Validation is the process of determining that the program functioned according to design. The programmer and content experts were used to further identify areas that needed revision or parts of the program that were not functioning properly (debugging). However, as a result of regular meetings with the production staff, and close scrutiny of the content at the time of its preparation, minimal time was required for debugging.

Implementation and Analysis

The final activities prior to pressing the master disc were completed during this phase. Beta versions (n = 12) of the program were loaded at outside test-sites for student analysis and field-testing. Undergraduate students from The University of Tennessee were asked to complete the program and report any problem areas. Students were also informally queried about their impression of the educational value of the program and user friendliness.

Distribution

After testing and revisions were completed, the CD-ROM was replicated in mass quantities (1000 copies) and distributed to students and faculty of participating colleges and universities offering a course in animal anatomy and/or physiology. Anyone who completed the questionnaire described above received a free copy of the CD.

Results and Discussion

Of the 106 land-grant colleges and universities surveyed nationwide with our questionnaire, 62 schools responded (Table 1). The majority of the respondents (n = 49) were from departments of animal, dairy, poultry and/or food science. The remainder came from departments of agriculture or veterinary science. Anatomy and physiology were taught as a combined course in 70% of the schools responding, and the majority (81%) of the classes had a laboratory where fresh or preserved specimens were used. All of the respondents indicated that they would incorporate multimedia support in the instruction of one or more aspects of their course. The respondents placed the greatest emphasis (66%) for support on problems associated with the neuromuscular system. Therefore, the name of the CD-ROM (Applications of Functional Anatomy in Farm Animals: The Somatic Portion of the Peripheral Nervous System) was chosen to emphasize this topic (Figure 1; Kattesh et al., 1999). The key features of the multimedia program are the following: flexible navigation; "expert" guidance; note taking; a glossary; text, graphics, and animation; a help system; user tracking; quizzes with feedback; and, instructor access to student files.

Table 1. Survey summary of 62 colleges and universities offering an undergraduate course in animal anatomy and physiology[z].

70% of the schools surveyed teach a combined course in anatomy and physiology
60% teach anatomy and physiology in both Fall and Spring semesters
51% of the classes have 10-50 students enrolled
81% of the classes have a laboratory. The live animals used are: cattle (70%), swine (50%), chickens, sheep/goats (45%), horses (30%)
81% of the classes use fresh specimens
50% of the instructors use problem-based teaching/learning
100% of the schools responding would use multimedia support for instruction of the following systems: nervous (66%), muscular (63%), respiratory (63%), digestive (61%), circulatory (61%), reproductive (59%), endocrine (56%), renal (54%), skeletal (49%), blood (46%)

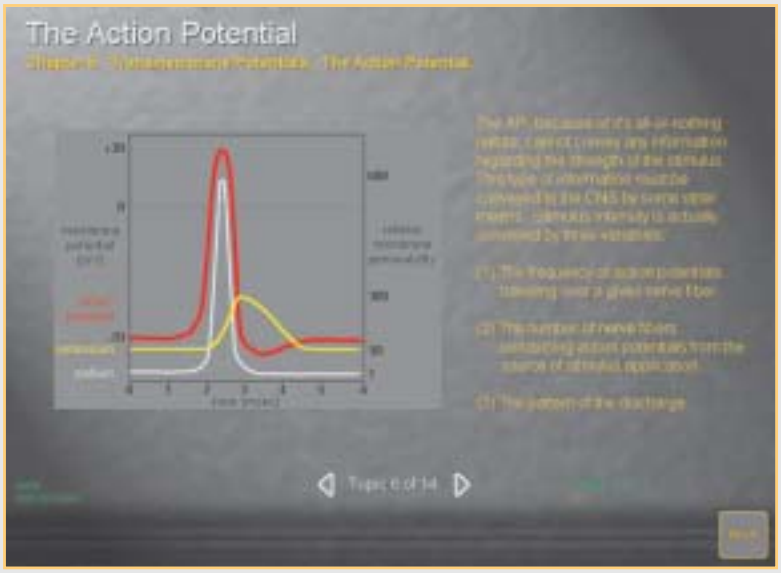
[z] Represents respondents of one-hundred six 1862 and 1890 land grant colleges and universities polled nationwide.

Figure 1. Applications of Functional Anatomy in Farm Animals: Somatic Portion of the Peripheral Nervous System, a multimedia CD-ROM.

The following is a brief description of the multimedia program. The student is required to place a diskette into the computer and logon using his/her name. This allows the program to track the student's progress and store the encrypted information on the diskette. The student proceeds at a self-determined pace through the program moving from the observation stage to the lesson stage and from there to the quiz and interaction with the content expert. Students are presented text, graphics, animation, and audio and video aspects relative to the anatomy and physiology of the somatic portion of the peripheral nervous system in nine lessons including a glossary of terms (Table 2; Figure 2). Each lesson requires approximately 30-60 minutes to complete. Mastery level of the lessons is assessed by 20 randomly selected multiple-choice questions from a 100-question bank (Figure 3). The student is provided his/her score immediately following completion of the quiz. The student may review the quiz to see which questions were missed, and is then directed to the lesson chapter from

Table 2. Lesson chapters for CD-ROM entitled *Applications of Functional Anatomy in Farm Animals: The Somatic Portion of the Peripheral Nervous System.*

Chapter	Title
1.	Organization of the Nervous System
2.	Body Fluids and Body Fluid Compartments
3.	The Cell Membrane and Transport Processes
4.	Transmembrane Potentials: The Resting Potential
5.	Transmembrane Potentials: The Action Potential
6.	Physiology of the Synapse
7.	The Physiology of Skeletal Muscle
8.	The Neuromuscular Junction: Membrane Excitation
9.	Receptors



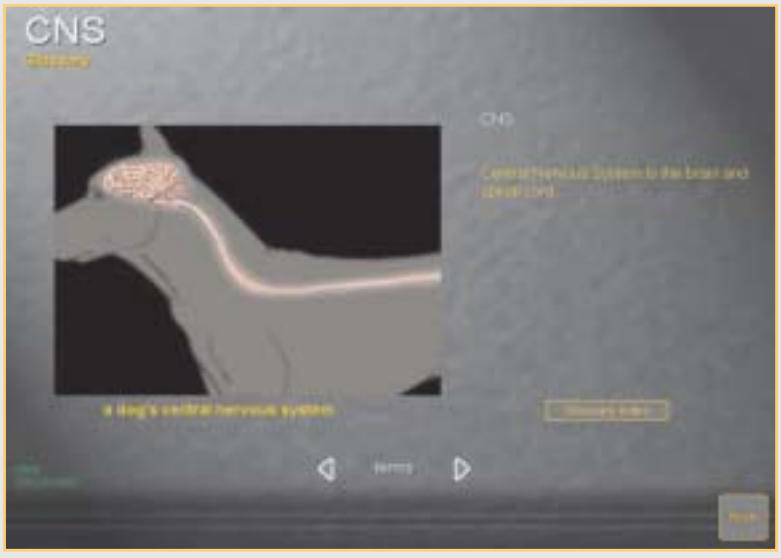


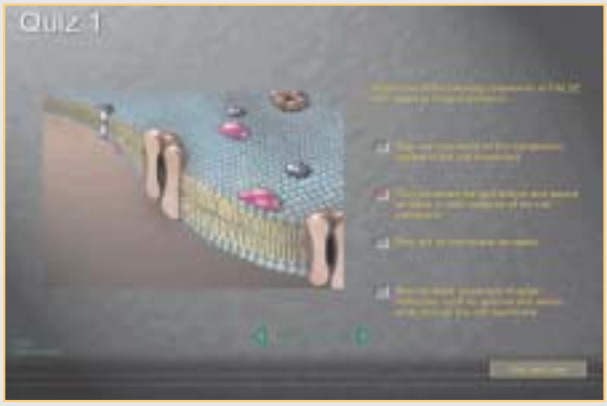
Figure 2. Instruction relevant to neuromuscular anatomy and physiology is provided through a series of lessons, including a glossary.

which the question was taken. Any student scoring less than 70% has to return to the chapters for remediation.

Four real-life case studies of neuromuscular abnormalities in the horse and cow are documented (Figure 4). The student is asked to make notes on an electronic notepad as to: 1) the body system most likely involved, 2) the seriousness of the problem, and specific observations that would be important in the diagnosis. The student is given complete control of the video and the notes are maintained throughout the entire program. Associated with any given pathology is/are the affected body system(s). By "dissecting" the causative factors of a selected pathology, using a variety of presentation methods available through multimedia technology (e.g. motion video of fresh specimens, radiographic images, drawings), we proposed that students would gain a better understanding of specific anatomical/physiological concepts as they relate to that particular system. Expert prompts, including history and details pertinent to each case, are provided in video and text format to aid the student in formulating initial observations (Figure 4).

After the student has passed the quiz and recorded his/her initial observations on one of the four cases, the student is then allowed to make a final diagnosis. The expert will conduct a step-by-step review of the case, providing comments about observations that the student should have made during the program. All input from the student, including quiz scores, initial observations and conclusions are stored on the diskette, which can then be turned in to the instructor. Using a separate program included in the CD-ROM, the instructor can review the student's quiz responses, case notes and conclusions (Figure 5).

This program underscores the practicality of understanding structural and functional relationships of the nervous and skeletal



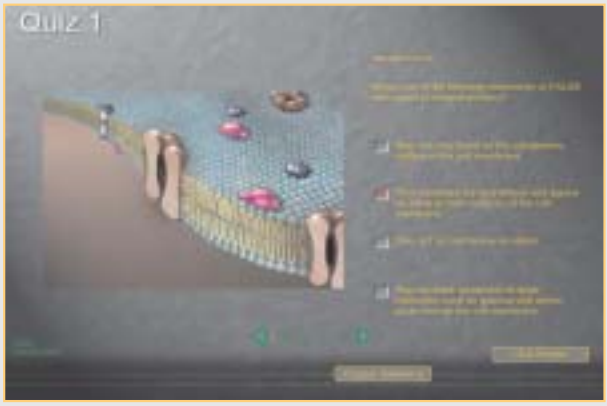


Figure 3. A student's mastery level of the lessons is assessed using 20 randomly selected questions and responses graded immediately by the computer, accompanied with feedback.

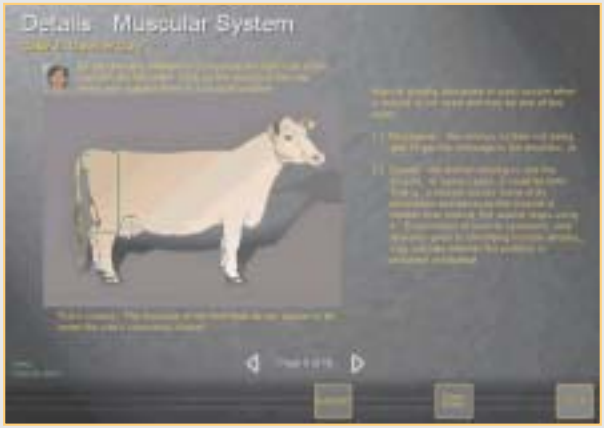


Figure 4. Self-paced interactivity allows the student to record observations and request additional information regarding the case study.

muscle systems that underlie commonly occurring neuromuscular abnormalities in farm animals. Experience in this mode of instruction will improve problem-solving skills of students as they practice applying physiologic concepts to their own observations. This program should significantly reduce the number of animals used in teaching laboratories and, in addition, provide institutions that have limited access to animals and/or prepared specimens similar advantages commonly afforded to larger universities directly associated with colleges of veterinary medicine. Self-paced interactivity on the part of the student will occur through navigational choices in the program. A contextual emphasis will certainly enhance the student's understanding of animal health issues and, in turn, have a positive impact upon animal well-being (Swanson and Thompson, 1993).

Figure 5. An accurate computer tracking of the student's progress enables the instructor to complete a final assessment of learning.

More than 200 undergraduate students majoring in animal science and wildlife and fisheries have already examined the program. The students unanimously appreciate the self-paced, interactivity of the program and commend us for using computer-assisted instruction over the conventional means of a text. The case-study approach to learning using animation, audio and video, was singularly the most liked feature of the CD-ROM. The main complaint of the CD-ROM was that some of the lesson chapters were too long. Since the distribution of the CD-ROM to approximately 75 US colleges and universities that offer a comparable course in farm animal anatomy and physiology, we have received favorable comments with regard to its quality, format, and innovative nature. Although the scope of the project did not include a formal study for comparing learning among those students who used the CD with those who did not, the informal input from those who used the program was very positive.

Summary

A multimedia CD-ROM program was designed and authored to aid students in learning the basic principles of functional anatomy of the neuromuscular system in farm animals using pertinent real-life examples of abnormal anatomy and/or physiology. A problem-oriented approach used in the program should add a much-needed relevancy to the study of anatomy and physiology and improve problem-solving skills as students gain intuition in the physiologic mechanisms underlying normal and abnormal physiologic processes.

Literature Cited

Clayton, G. S. and B. Wilson. 1988. Computer-assisted learning in medical education. Med. Educ. 22:456-467.

Curless, E. and Y. J. Coover-Stone. 1987. Simulating clinical situations:interactive videodisc. Dimensions of Critical Care Nursing 6(4):249-254.

Jensh, R. P. 1987. Use of interactive-video programs in education in basic medical science. J. Med. Educ. 62:942-944.

Kattesh, H. G., M. H. Sims, and R. W. Henry. 1999. Applications of functional anatomy in farm animals: The somatic portion of the peripheral nervous system. A multimedia CD-ROM, Department of Animal Science, The University of Tennessee.

Love, G. M. and E. P. Yoder. 1989. An assessment of undergraduate education in American colleges of agriculture. The Pennsylvania State University.

Newcomb, L. H. and M. K. Trefz. 1987. Toward teaching at higher levels of cognition. NACTA 31(2):26-30.

Singarella, T., S. Bader, and H. J. Ramagli. 1988. Videodisc utilization trends in the health sciences. J. Biocomm. Summer:26-29.

Stevens, R. H., A. R. Kwak, and J. M. McCoy. 1989. Evaluating preclinical medical students by using computer-based problem-solving examinations. Acad. Med. 64:685-687.

Swanson, J. C. and P. B. Thompson. 1993. Public issues and concerns. In Food Animal Well-being. Conference Proceedings and Deliberations. USDA and Purdue University.

Whittington, S. and L. H. Newcomb. 1990. Teaching at higher levels of cognition. NACTA 34(2):20-23.