1995

Multimedia interactive computer assisted learning (MICAL) for athletic trainers

Gregg Gould
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**MULTIMEDIA INTERACTIVE COMPUTER
ASSISTED LEARNING (MICAL)
FOR ATHLETIC TRAINERS**

A Project

Presented to

**The Faculty of the Department of Human Performance
San Jose State University**

**In Partial Fulfillment
of the Requirements for the Degree
Master of Arts**

by

Gregg Gould

August 1995

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This thesis makes reference to information on a CD-ROM (MICAL).
Copies of the CD-ROM can be received from the author by contacting the
Department of Human Performance at San Jose State University.

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ABSTRACT
MULTIMEDIA INTERACTIVE COMPUTER ASSISTED LEARNING (MICAL)
FOR ATHLETIC TRAINERS

by Gregg R. Gould

This project's purpose was to create a multimedia interactive computer assisted learning (MICAL) program to supplement and enhance traditional education in athletic training. MICAL provides the user with the following information: (a) structural and functional anatomy of the knee, (b) injury observation of the knee, and (c) examination protocols for knee injuries. MICAL allows the user to be tested on material previously learned. Key attributes of MICAL are: (a) it's design allows systematic learning at the user's own pace, (b) each component can be accessed for reference, (c) it provides a multimedia interactive environment which supports Krahe's ideal learning. The development of the MICAL program was accomplished through three phases: (a) model construction and animation on Silicon Graphics™ workstation, (b) video capturing and digitizing, and (c) development of MICAL with Macintosh computers. Internal validity was established through peer debriefing, member checking, and triangulation. An audit inquiry established that the findings were logical and coherent.

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CHAPTER 1

PRESENTATION OF THE PROBLEM

Introduction

The National Athletic Trainer's Association (NATA) has always recognized the need to train professionals. In fact, the organization is dedicated to preparing true health care experts (Perrin & Lephart, 1987). According to Draper (1987), a health care expert is an individual with a specialized educational background in any of the allied health professions recognized by the American Medical Association. The development of quality health care professionals has been a primary concern of the NATA since its origin in 1950. A major objective since the NATA's inception has been to ensure quality education for the preparation of athletic trainers.

NATA's certification examination originated in 1970 and was designed to ensure the admission of qualified athletic trainers. According to the policies set forth by the NATA, there are seven main areas in which the student athletic trainer must have competent understanding to pass the certification examination. These areas are: (a) prevention of athletic injuries/ illnesses, (b) evaluation and recognition of athletic injuries/ illnesses and medical referral, (c) first aid and emergency care, (d) rehabilitation and conditioning, (e) counseling and guidance, (f) organization and administration, and (g) education (Draper, 1987).

With the implementation of the national certification examination, the professional preparation of athletic trainers has increased considerably in substance and sophistication (Perrin & Lephart, 1987). Before 1970, accredited athletic training programs at either the undergraduate or graduate level were

nonexistent. Presently there are 88 NATA approved undergraduate and 12 NATA-approved graduate level curricula ("NATA Constitution," 1994). In addition, the quality of education was ensured in June of 1982 when the NATA's Professional Education Committee announced that universities and colleges offering athletic training curricula would have to meet standards established by the NATA. The Professional Education Committee stated that by July 1, 1986 colleges and universities offering athletic training programs were required to implement the standards set forth by the NATA (see Appendix A, p. 65). Full implementation of these standards were to be completed by July 1, 1990 (Rudd, Templin, & Toriscelli, 1988). In compliance with the academic guidelines set forth by the Professional Education Committee, the NATA has enhanced the breadth and depth of the athletic training education curriculum for the purpose of training qualified athletic trainers.

The NATA's objective was to assure that the appropriate classes were present within the athletic training curriculum to produce qualified competent entry-level athletic trainers (see Appendix A, p. 65). Although NATA has assured proper educational requirements for athletic training majors, there are still questions as to whether entry-level athletic trainers are ready for the profession. Many entry-level certified athletic trainers have stated they do not feel adequately prepared for an athletic training position. Rudd, Templin, and Toriscelli (1988) attribute this feeling of inadequacy to either insufficient clinical hours or inadequate clinical experiences. Furthermore, respondents from a study conducted by Buxton, Lankord, and Geik (1992) "felt that their mentors/certified athletic trainers could have provided more leadership,

guidance, and evaluation" (p. 322). In addition, Weidner and Vincent (1992) evaluated the professional preparation ability of colleges and universities offering athletic training as a curriculum. Their results indicate that colleges and universities are preparing student athletic trainers in terms of a knowledge or theoretical base; however, their clinical skills in the applied setting were limited. Weidner and Vincent (1992) concluded that student athletic trainers have limited exposure to sport injuries and consequently, they are unable to differentiate from one injury to another. In another study by Duncan and Wright (1992), it was revealed that certain task areas needed increased emphasis to assure quality professional preparation. The areas which required increased emphasis were: (a) skill development, (b) recognition and evaluation, (c) rehabilitation, and (d) prevention of athletic injuries.

Although the NATA established guidelines for quality education, researchers have expressed that there is no link between the traditional educational setting and the clinical or work environment (Brown, Collins, & Duguid, 1989; Lave, 1988; Rogoff and Lave, 1984). Brown, Collins, and Duguid (1989) concluded that education has assumed a separation between knowing and doing, treating knowledge as an integral, self-sufficient substance, theoretically independent of the situation in which it is learned and used. Lave (1988) and Rogoff and Lave(1984) point out that learning should be an everyday event that is social and interactive in nature. According to Lave (1988), learning becomes environment-dependent when the educational setting provides the mechanisms that aid and structure the cognitive process allowing the student to act and interact with context. Weidner (1989) expressed

that it was possible that students were not obtaining essential information to be successful in the athletic training profession because of the impacted educational requirements and the minimal requirements of clinical hours. He further concluded that the student athletic trainer was unable to retain necessary information to be successful because of the stiff requirements set forth by the NATA. Weidner (1989) expressed that:

At the rapid rate our student athletic trainers are learning, it is almost impossible for them to develop or retain a high degree of proficiency in all of the many knowledge areas and skills to which they are exposed. In fact, it is difficult for even the most experienced athletic trainer to maintain a high level of skills in an area in which exposure is limited . . . (p. 146)

Beale (1993) has expressed that students tend to learn according to how they are tested. When students are tested for facts, they tend to memorize facts, when they are asked to analyze relationships, they learn to think critically and engage in problem solving. Consequently, when the style of preparation consists of short-term memorization, the true learning plateau is never reached. Beale (1993) further expresses that education at the college level involves three qualities which form the foundation of learning. More specifically, acquired knowledge should be conceptual, general, and traditional. College-level learning implies a conceptual as well as a practical grasp of the knowledge. In other words, the concepts, theories, and principles learned can be articulated. In addition, college learning should be general; it should be applicable outside the specific setting in which it was learned. Finally, college-level learning should be traditionally taught, which involves the acquisition of knowledge and application of related skills.

Since learning at the college level consists of three components, the question should be which component or components are not meeting the needs of student athletic trainers. Conceptually, there seems to be no conformity between the concepts, theories, and principles learned. According to Beale (1993), the student tends to study and learn what he or she perceives the teacher will test for, instead of learning all of the material presented. This prohibits the student from gaining a total understanding of a particular principle or approach. The athletic training curriculum is designed to develop principles or approaches by combining material presented in multiple classes. A foundation may be established in one class and the framework continued in another class. Consequently, if the student athletic trainer develops a knowledge base solely directed toward the testing tool, important material may be omitted. Thus when it comes time to manage an injury, the athletic trainer may have insufficient skills to successfully respond to the injury. Not only is the knowledge base insufficient, the student also lacks the ability to apply the knowledge and skills he or she has acquired in the clinical setting.

Krahe (1993) addresses the problems presented by Beale (1993) by expressing the importance of interactive learning and problem solving.

According to Krahe (1993),

The ideal learning style would allow the individual to get involved fully in a concrete experience, then would offer him or her the opportunity to detach himself or herself from the experience in order to reflect on it from many different perspectives; then with the help of the perfect learning style, the person would create theories from the observations or reflections that were generated, and finally would call upon these theories to make decisions and to solve problems inherent in new concrete experiences.(p. 17)

Thus Krahe's (1993) model provides the learner an environment where optimal learning can occur. In other words, the learner is interactive, reflective, and concretely involved in an environment which involves active decision making.

In a study conducted by Draper (1989) on learning styles, he concluded that the majority of athletic trainers are independent learners with a kinesthetic preference. "Kinesthetic learners have a tendency to learn best from experience and self-involvement. They require a variety of stimuli and attempt to touch or manipulate the learning material" (p. 235).

Based on the research previously cited, the objective of this project was to develop a learning tool which is conducive to multiple learning styles. The Multimedia Interactive Computer Assisted Learning program (MICAL) is a tool which teaches skills that are applicable to the work environment. This program requires the student to interact, conceptualize, and apply problem solving skills related to the athletic training experience.

Statement of the Purpose

The primary goal of this project was to develop MICAL which offers a new approach to learning in athletic training. MICAL provides both the student and experienced athletic trainer a comprehensive computer assisted aid for learning in an interactive, and problem solving environment. Computer-assisted learning in athletic training offers several advantages when used in conjunction with traditional teaching methods: (a) the design of MICAL allows the user to systematically learn at his or her own pace, (b) any aspect of MICAL (video, animation, text, or test) can be accessed quickly and repetitively, (c) MICAL presents an environment in which the learner can be interactive, reflective, and

concretely involved in active decision making which promotes an ideal learning setting, and (d) MICAL involves kinesthetic, visual, and auditory learning.

Statement of the Problem

The general objective of this study was to create a Multimedia Interactive Computer Assisted Learning (MICAL) program for athletic trainers. Specifically the MICAL program was developed as a learning tool to teach athletic trainers about the structural and functional anatomy of the human knee as well as injury assessment, and injury observation of an injury to the human knee. Krahe's (1993) ideal learning setting was given consideration in accomplishing these objectives by allowing students to become interactive, reflective, kinesthetic and problem solving learners.

Traditional athletic training education is limited in its ability to effectively meet the educational needs of the student athletic trainer, as a qualified health care professional. In addition, traditional education needs to be interfaced with the work environment (Brown, Collins, & Duguid, 1989; Lave, 1988; Rogoff and Lave, 1984). The computer as a multimedia learning tool can be used to enhance the learning environment for student athletic trainers. In addition, computer software can be developed and implemented to supplement and enhance traditional learning methods. Finally, computer learning should be available to the student athletic trainer, as well as the most experienced athletic trainer.

Delimitations

MICAL is delimited to the following:

- 1) A multimedia computer assisted learning program capable of

running on a Macintosh™ 68030 CPU computer or higher with a minimum of 4 MB of ram.

2) A Multimedia-interactive computer assisted learning program related to the functional and structural anatomy of the knee and injury observation and evaluation of the knee.

3) Specific cognitive components related to the knee such as the anatomy, injury observation, injury assessment, and surgical treatments.

4) A literature review regarding athletic trainer's learning patterns, benefits of incorporating multimedia interactive computer assisted learning with traditional education, effective computer assisted learning design approaches, consideration of human factors in the interface design, and important aspects related to the care and management of the human knee injuries.

Limitations

The limitations to MICAL are as follows:

1. The three dimensional models and animations presented in the MICAL program are limited to the author's artistic ability.

2. The three-dimensional models and animations are limited to the Alias™ program capabilities.

3. MICAL's technical development is limited to the capabilities of Macromind Director™.

Assumptions

Assumptions of the production of the MICAL are as follows:

1. There is a need for the development of MICAL. With the evidence presented in the review of literature, the need for alternate learning tools in the

field of athletic training has been established.

2. The target population for MICAL has access to, or owns, a Macintosh™ 68030 CPU computer or higher with a minimum of 4 MB of ram.

Definitions

Alias™: A three-dimensional graphics and animation program which runs on the Silicon Graphics™ workstation.

Athletic Training: "Is the link between the athletic program and the medical community for the implementation of injury prevention measures, emergency care, and injury management" (Arnheim, 1988, p.16).

Athletic Trainer: A highly educated and well trained professional. The major functions include the following: (a) injury prevention, (b) recognition and evaluation, (c) management, (d) treatment, (e) disposition, (f) rehabilitation, (g) organization, (h) administration, (i) evaluation, and (j) counseling of the athlete.

Ideal Learning: As defined by Krahe (1993) the ideal learning style allows the individual to become fully involved in a concrete experience with the opportunity to withdraw from the experience for reflective analysis. The ideal learning environment allows the individual to call upon these experiences later in life for the purpose of problem solving and decision making.

Computer-Assisted Learning: The various ways which emphasize the use of computers for the initiation and promotion of the learning processes (Barker & Manji, 1992).

Multimedia: The process of combining text, video, sound, and animation to create a program which can be viewed by others for enjoyment, learning, or application.

Macromind Director™: A multimedia authoring program which runs on the Macintosh™ computer system. This program allows the user to create computer-assisted interactive learning programs which use text, video, sound, and animation.

NATA: The National Athletic Trainer's Association (NATA) was organized in 1950 to serve athletic trainers and the physically active. The organization works for educational advancement of the athletic training profession (see Appendix B, p. 66).

Silicon Graphics™ Workstation: A computer which runs through the Unix operating system. The workstation was designed for the production of computer generated three dimensional models and animation.

Summary

The profession of athletic training has made significant advancements since the provenance of the NATA in 1950. The NATA has instilled the importance of education as the key to the advancement of the profession. In addition, the certification examination was developed in the 1970's to assure that only qualified athletic trainers would be eligible to enter the profession. In the 1980's NATA's Professional Preparation Committee established curriculum standards for colleges and universities which offered curricula in athletic training. This represented another step to assure that only qualified individuals would be entering the field of athletic training.

Efforts have been put forth by the NATA to assure the production of qualified individuals entering the health care profession. However, questions have been raised by experts (Brown, Collins, & Duguid, 1989; Lave, 1988;

Rogoff and Lave, 1984; Draper, 1989; Krahe, 1993; McCormick, 1993; Draper, 1987) about the quality of professional preparation for entry-level athletic trainers. As stated earlier, many educational experts (Brown, Collins, & Duguid, 1989; Lave, 1988; Rogoff and Lave, 1984; Krahe, 1993; McCormick, 1993) have expressed that the material being taught to the students in the classroom is not being successfully used in the work environment. In addition, many entry-level certified athletic trainers feel the number of clinical hours required is inadequate (Draper, 1987) and that the clinical environment in which the student acquires his or her hours is also inadequate (Weidner & Vincent, 1992; Buxton, Lankord, & Noda, 1992).

The purpose of this project is to provide an educational tool for the student athletic trainer and a reference source (whether it be visual, auditory, or textual) for the certified athletic trainer. Multimedia Interactive Computer Assisted Learning (MICAL) can be used in conjunction with traditional teaching methods to enhance the learning experience. In addition, this project can serve as a reference or learning source for professionals (established athletic trainer) who are unfamiliar or unclear about a specific aspect of a particular knee injury.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

The researcher collected information on the importance of producing the MICAL project through multiple literature searches. In addition, information was acquired on how to properly design MICAL. The review of literature involved the following topics: (a) athletic trainers' learning style, (b) benefits of computer assisted learning (CAL), (c) technical design of the computer assisted learning (CAL) program, (d) human factors involved in program design, and (e) significant information to be covered in MICAL. In this chapter, the researcher establishes credibility for the proposed project through triangulation. Triangulation refers to the use of multiple sources for evaluating specific information (Lincoln and Guba, 1985).

Athletic Trainer's Learning Style

Although students develop learning patterns based on their particular study environment, there is a basic foundation for college-level study which is consistent in all learning patterns (Krahe, 1993). The basic foundation of college level learning consists of three components: (a) conceptual, (b) general, and (c) traditional (McCormick, 1993; Krahe, 1993). First, college level learning implies both a conceptual and a practical grasp of the knowledge or competent understanding of a specific knowledge base. This means that the concepts, theories, and principles learned can be articulated (McCormick, 1993). Next, college learning is general. This means that it should be applicable outside the specific setting in which it was learned. Finally, "college

level learning should be traditionally taught. This means the standard of teaching should be at a level of undergraduate achievement, as opposed to secondary or continuing education" (McCormick, 1993, p.20).

Although the majority of athletic trainers are independent/kinesthetic learners, conceptualization, generalization, and traditionalism are still present in their learning patterns. Independent learners tend to learn best and be more efficient when they work and learn by themselves (Draper, 1989; Beale, 1993; Krahe, 1993). Independent learners also value their own opinion more than the opinion of others (Beale, 1993; Krahe, 1993). In addition, Draper (1989) believes kinesthetic learners tend to learn best from experience and self-involvement. He also states that "The kinesthetic learner requires a variety of stimuli and attempts to touch or manipulate learning material" (p. 235). Draper (1987, 1989) has established a philosophy of education for the student athletic trainers as reflected in the following statement:

Athletic training education at the university level should include:
(a) Use of "hands on" activities as a part of class room training; (b) opportunities for independent learning; (c) strategies for improving reading comprehension; (d) written and oral examinations, and (e) mentor evaluation. (p. 234)

Computer Assisted Learning and the Educational Setting

Guthrie and McPherson (1992) conducted a study to determine whether there is an increase in the student's ability to learn when using computer-assisted learning (CAL). The subjects consisted of 45 undergraduate students. The students were assigned to two separated groups through a randomized crossover approach. The study design consisted of exposing two groups to a traditional learning environment (teacher-student interaction), a

modified traditional learning environment (the modified portion consisted of a CAL program designed to assist the student with the subject material), and a traditional teaching environment with the option of using CAL. The students were then tested at the end of each teaching session. A statistical analysis using a paired t test and analysis of variance indicated significant improvement in the test scores when CAL was implemented. Thus the findings showed positive results from using the modified teaching approach. In addition, when CAL was made optional, 71% of the students opted to use the program.

Askar, Yavuz, and Koksai (1992) conducted a study involving 137 students who were enrolled in a computer assisted science learning class. The class was one month in length. The subjects were tested to disclose their attitudes, perceptions, and the relationship between their perceptions and attitudes. The subjects expressed positive attitudes toward learning on the computer. The results indicated that the subjects preferred to learn when colorful graphics and animation were used. The subjects showed an increase in attention span. An increase in the student's interest and understanding of the material presented was also documented. According to the results of the study, 63% of the students found the use of computer to be both enjoyable and interesting and would like to incorporate computers into all of their course work. Finally Askar, Yavuz, and Koksai (1992) conclude:

A significant positive relationship was found between attitudes and perceptions in the computer assisted learning environment; students who indicated that the CAL environment was better than the conventional classroom thus have a more favorable attitude towards CAL. This means, of course, that the factors which influence the success of CAL and the implementation of computer use in the school must be carefully handled (p. 138).

Lazarowitz and Huppert (1993) conducted a study involving 181 entry-level biology students. The subjects were divided into a control group and an experimental group. The experimental group was introduced to a CAL program in addition to traditional laboratory work, while the control group performed only traditional laboratory work. The study was to determine if CAL, when integrated with classroom laboratory work, would affect the student's achievement of problem solving skills. At the end of each laboratory experiment the students were tested. The results indicated that there was an increase in the experimental subject's test results. The authors attributed the increase in the experimental group's scores to the implementation of the CAL program. Finally, the authors observed an increase in interest and enthusiasm with the experimental group which was not present in the control group.

Shlechter and Bessemer (1992) studied CAL and role playing to determine if the two allowed for optimal learning. "The investigation examined the effectiveness of a CAL program combined with a program of role playing activities for helping students to master the knowledge needed for successful field performance" (p. 110). This study examined 607 military students. Four hundred and seventy were placed in both the CAL program and the activities field program while the remaining students (130) only participated in the field activities program. The results indicated that the subjects involved in both the CAL and the field activities program had better scores on field tests than the subjects involved in the field activities program only. Schlechter and Bessemer (1992) concluded that "the effectiveness of such CAL programs is seemingly tied to providing students with realistic and safe 'learning by doing'

opportunities" (p. 114).

The above review of literature (Askar, et al. 1992; Guthrie & McPherson 1992; Lazarowitz & Huppert 1992; Shlechter & Bessemer, 1992) indicates that CAL programs can function successfully as a supplemental learning tool for traditional education. Although the above studies were conducted in different fields of education, each proved that a CAL program was beneficial. The researcher therefore concluded that the design of the MICAL program would be a beneficial learning tool for athletic trainers.

Technical Design

De Jong, Van Andel, Leiblum, and Mirande (1992) conducted a study in the Netherlands to determine the results of the 442 different CAL programs in higher education programs. The findings indicated that the most frequently chosen CAL programs involved simulation followed by tutorial applications. The study also indicated that the particular sub-disciplines within education have different needs regarding CAL programs. Consequently, CAL programs have been modified to meet the needs of each subject area. According to De Jong et al. (1992), "In the sciences, CAL programs emphasize simulation, whereas for economics and law, structured tutorials are emphasized, and in humanities more emphasis is placed on situational drills in the application" (p. 381). In addition, results from this study indicate that CAL programs allowed more freedom for the user which enhanced personal learning.

Hutchings et al. (1992) examined CAL and learning goals which must be addressed to develop an effective program. Three conditions were identified as being essential:

- (a) Learning is not unitary, meaning there has to be multiple

approaches to satisfy the need of the user; (b) Knowledge domains differ widely in their natural structure and in the requirements they demand of the user, and (c) Learners differ, not only in terms of abilities, strategies and styles, but in their goals and contexts.(p 172)

In addition, the above researchers believe that a deeper level of learning is more likely to occur when the student is disengaged from the computer for the purpose of reflection, problem solving, and/ or decision making. This concept supports Krahe's (1993) belief that an ideal learning environment must always allow the student to detach himself or herself from the experience to reflect upon numerous dimensions. Krahe (1993) takes this concept a step further by pointing out that theories are actually created from observations and reflections of concrete experiences.

Johnson and Grover (1993) also examined key components of a successful CAL program. The successful components were: (a) learner control, (b) practice, (c) feedback, and (d) learning resources. Of these, learner control was thought to be the most important aspect of a successful CAL program. According to Johnson and Grover (1993), "Sophisticated learner-directed branching stimulates the active learner to manage the sequence of events" (p. 8). Examples of learner control include: (a) the ability of the user to move either forward or backward in the program, (b) instant access to any portion of the program, and (c) the ability to access more definitions, resources, tests, or examples. Practice was another important component. This component of the CAL program allowed the user to experience repetition of various tasks or problems which simulates the real world (random data worksheets). According to Johnson and Grover (1993), computer feedback involves ". . . selected

responses from sizable pools of appropriate responses; it also offers more elaborate directions on tries following inappropriate responses, tolerates spelling errors, and displays comprehensive graphical evaluations" (p. 8). Finally, learning resources are similar to learner control; they give the user the access to elaborate indexes. The above researchers also point out that, "Learning resources deliver instant access to elaborative learning resources including meanings, substantive vocabulary, and related concepts" (p. 12).

According to Cortinovis (1992), "The CAL program has to satisfy two main purposes: training and referencing" (p. 48). In other words, the user should be able to access information within the program through referencing (either through referencing a particular item or through a systematic teaching method). By having multiple options available to the user, the program has the ability to meet Krahe's (1993) ideal learning platform. Other components of importance, are: (a) ease of use, (b) efficiency, and (c) ease of memory. For ease of use the user should be able to sit down and with minimal instructions begin to accomplish something. For the program to be efficient, the user should have a high level of productivity once the CAL program is learned. A program is easy to remember when the user can return to it after an extended period of time and proceed where he or she left off. Furthermore, a program should be designed to prevent minimal user errors, and if an error occurs, the user can easily recover. Finally, it is important that the user is subjectively satisfied with the outcome after using the program.

Human Factors

According to Graver (1986), the incorporation of sound to instruct the

user enhances the program's usability. Program usability " . . . is the ability of the user to enter a program environment and be able to execute his or her desired plan, whether that be to learn about the program, learn from the program, or navigate throughout the program" (Graver, 1986, p. 169). Graver (1986) examined the user's ability to maneuver throughout the program with the instruction of sound. In addition, the study examined the user's ability to retain information when it was presented in an auditory manner versus in a visual manner. Graver (1986) concluded that, " By using auditory icons and/or characters of naturally occurring sounds, information about sources of data can be provided in a natural way to represent dimensional data as well as conceptual objects in a computer system or program" (p 175). Thus by using both visual and auditory representation, the user's ability to interact with the computer program is enhanced.

Bodker (1989) examined a HyperCard stack which was designed to determine the quality of the human computer interface design. Bodker's study tested the ability of a computer program to simulate the traditional teaching environment. Bodker determined that the program design should resemble as close as possible the natural environment in which the user population is accustomed. As applied to MICAL, the program should be constructed to resemble the athletic training environment. Bodker (1986) concluded that a computer program which incorporates the many multimedia components will broaden the user population.

Grudin (1991) has pointed out that large organizations that develop commercial software products should eliminate poor interface features resulting

from carelessness, ignorance, or neglect in the development process by including user involvement during the interactive design. This can be done by presenting a prototype of the program to a sample population. The sample population tests the prototype and gives feedback to the programmer to eliminate weakness in the design. In addition, the developer attempts to create a program environment which simulates that of target populations. According to Grudin (1991), if the software company follows the above rules, they will develop a product that incorporates good human computer interface design which will result in a program that is both user friendly and marketable.

Brown and Simpson (1994) have established three guidelines for the development of successful computer programs involving human factors:

1) Technology should be polite and forgiving. The user should be greeted in a pleasant manner and the computer should avoid being rude and inconsiderate.

2) Technology should adapt to people whenever possible; people should not be required to adapt to technology. For the twenty-first century, this means the program should be efficient and time saving.

3) Prototypes should be evaluated throughout the production of the program to eliminate ineffective human computer interface design by employing "Usability testing." "Usability testing is the observation of people using a product or system during its creation to provide direction for the design team" (Brown and Simpson, 1994, p. 148).

Material Covered in MICAL

The technical development of the MICAL program, as well as

essential cognitive and instructional material, are important for its success. As discussed earlier, MICAL is a multimedia computer assisted learning program of the human knee, which covers the following material: (a) anatomy, (b) injury observation, (c) Injury assessment, and (d) surgical treatment. The material which was chosen for MICAL was decided through the process of triangulation. A literature reviewed involved the following experts in the field of sports medicine: Arnheim, (1989); Feagin, (1988); Hoppenfeld, (1976); and Magee, (1989). Material used in MICAL was referred to by two or more of the above authors.

Anatomy

The muscles of the knee joint can be broken down into four quadrants: (a) anterior, (b) posterior, (c) medial , and (d) lateral (Hoppenfeld, 1976). The anterior quadrant is composed of the rectus femoris, vastus lateralis, vastus medialis, and the vastus intermedius (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; and Magee, 1989). The anterior quadrant is also referred to as the quadriceps muscle group and it functions by extending the lower leg. The muscles of the anterior quadrant all come together to insert into the patella via the pateller tendon (Arnheim, 1989).

The posterior quadrant is composed of the biceps femoris, semimembranosus, semitendinosus, and the gastrocnemius (Arnheim, 1989, Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). The biceps femoris, semimembranosus, and semitendinosus comprise the hamstring muscle group. The biceps femoris inserts on the posterior portion of the fibula. The semitendinosus inserts into the medial tuberosity via the pes ansurinus tendon.

The semimembranosus inserts into the posterior medial side of the tibia.

Finally, the gastrocnemius originates from two separate points on the femur.

The medial head originates from the medial posterior portion of the femur, while the lateral head originates from the lateral posterior portion of the femur. The function of the muscles in the posterior quadrant is flexion of the lower leg.

The lateral compartment is comprised of the tensor fascia latae. This muscle originates from the ridge of the iliac crest and inserts into the lateral tubercle of the tibia, also known as Gurdy's tubercle (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). This muscle assists in knee flexion and extension.

Finally, the medial compartment is comprised of the sartorius and gracillias. These muscles originate from opposite sides of the ilium and come together to join the semitendinosus at the pes anserinus tendon (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). The pes anserinus tendon then inserts into the medial tubercle. The gracillias and sartorius have two functions: (a) they assist in flexion of the lower leg, and (b) they internally rotate the lower leg.

According to the literature, the bones are held together by the anterior and posterior cruciate ligaments, lateral and medial collateral ligaments, and the superior tibial fibular ligament (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; and Magee, 1989). The anterior and posterior cruciate ligaments originate from the femur and insert into the tibia. Their primary functions are to prevent anterior and posterior translation of the tibia. The collateral ligaments originate on each side of the tibia respectively. The medial collateral ligament

inserts into the medial side of the tibia and the lateral collateral ligament inserts into the head of the fibula (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). The collateral ligaments function to prevent valgus and varus force within the knee joint. The superior tibial fibular ligament connects the fibula to the tibia and prevents subluxation of the fibula.

According to the literature, there are two menisci which lie on top of the tibia and separate the tibia from the femur (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; and Magee, 1989). The names of the menisci are the lateral and medial menisci. According to Magee (1989), the functions of the menisci are shock absorption, lubrication, nutrition, enhancement of joint surface congruency, and improvement of weight distribution.

The knee is comprised of four separate bones: (a) tibia, (b) fibula, (c) femur, and (d) patella. The femur and the tibia serve as weight bearing bones. The fibula serves as a stabilizing bone for the muscle so lower quadrant. The patella serves to enhance biomechanics during leg extension.

Injury Assessment

Injury assessment of the knee involves (a) a thorough history (finding out everything possible about the injury), (b) inspection (looking for abnormalities around the injury), and (c) palpation which involves feeling the anatomical structures around the injury to detect abnormalities (Feagin, 1988). In addition, functional tests are performed on structures around the injured area to identify the actual structure injured.

In MICAL, the assessment portion of the program tests the integrity of individual structures (ligaments, menisci, and muscle). The ligament tests are

broken down into two specific groups: the cruciate ligaments and the collateral ligaments. The tests for the cruciate ligaments are: (a) anterior and posterior drawer test, (b) the Lauchman's test, and (c) the posterior sag test (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). The tests for the collateral ligaments are the valgus stress test at zero degrees and fifteen degrees flexion and the varus stress test at zero degrees and fifteen degrees flexion (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989).

The menisci tests are: (a) the McMurray's test, (b) Apply's compression test, and (c) the knee squat test (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). Tests for the menisci determine the location of the meniscus tear but, are unable to determine the type of tear (Arnheim, 1989). On the other hand, a functional test can determine the extent of the ligament damage.

Finally, the functional test for muscles consists of evaluating the muscle's strength. Each of the muscle quadrants is tested separately to determine if muscle damage has occurred. The tests include: (a) passive range of motion (the examiner moves the lower limb through a complete range of motion), (b) active range of motion (the individual moves the lower limb through a complete range of motion), (c) isokinetic muscle testing (the individual moves the lower limb through a complete range of motion against resistance), and (d) isometric testing (the individual holds the limb at a particular angle while maximal resistance is applied) (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; and Magee, 1989). The above steps were captured on video and digitized into the computer but were not included in the MICAL program.

Injury Observation

The injuries included in MICAL consisted of all structures previously mentioned. Muscular or tendon injuries are graded as follows: (a) first degree consists of microscopic tissue damage, (b) second degree consists of a partial tear, and (c) third degree consists of a complete tear or rupture (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). Next, ligament injuries involve tissue tearing when abnormal stress is placed on the knee joint. Ligament injuries are graded the same way as muscular or tendon injuries. Two types of injuries can occur with a meniscus: tearing or bruising of the meniscus. The types of tears which can occur are: (a) horizontal cleavage tear, (b) longitudinal tear, and (d) bucket handle tear (Arnheim, 1989; Feagin, 1988; Hoppenfeld, 1976; Magee, 1989). The primary injury to the bones of the knee is a fracture. The type of fractures include: (a) avulsed, (b) commuted, (c) sheared, (d) osteochondral, (e) chondral, and (f) depressed (Feagin, 1988).

Summary

The purpose of this Review of Literature was to comprehend an effective learning process for athletic trainers. Studies (Krahe, 1993; & McCormick, 1993) indicate three basic components which comprise the foundation of college-level learning: (a) conceptual, (b) general, and (c) traditional. Draper (1989) also recognized that these three components are critical for college-level learning. He also indicated that student athletic trainers are independent/kinesthetic learners. Through this understanding the researcher was able to develop MICAL to meet the independent/kinesthetic attributes of the athletic trainer's learning style. Various studies (Askar, et al.,

1992; Guthrie & McPherson, 1992; Lazarowitz & Huppert, 1992; Shlechter and Bessemer, 1992) showed positive results both in student's test scores and in their enthusiasm when a CAL program was implemented. However, research has not been conducted on the effects of a CAL program used in athletic training. Studies in other disciplines (Askar, et al., 1992, Guthrie & McPherson, 1992; Lazarowitz & Huppert, 1992; Shlechter & Bessemer, 1992) have reported positive outcomes through the use of CAL. In addition, various studies (De Jong et al., 1992; Hutchings et al., 1992; Johnson & Grover, 1993; Cortinovis, 1992; Krahe, 1993) validated important components which are essential for CAL programs such as: (a) oppertunities for reflection, problem solving, and decision making; (b) the need for practice, reflection, feedback, and learner control; and (c) the importance of interactive learning and learning by doing. The above components will be incorporated into MICAL as an effective learning tool. Finally, the researcher referred to various authors (Arnheim, 1989; Feagin, 1989; Hoppenfeld 1976; Magee, 1992) to establish triangulation for important information related to structure, function, and assessment, of the human knee.

CHAPTER 3

PROCEDURES

Introduction

The purpose of this project was to provide an educational tool for the student athletic trainer which enables him or her to incorporate Krahe's (1993) ideal learning environment (see p.5). State-of-the-art computerized technology was used to create and market a multimedia learning tool to understand the structural and functional nature of the human knee. This state-of-the-art technology included Silicon Graphics™ workstations and Macintosh™ computers and their respective software. Multimedia interactive computer assisted learning (MICAL) incorporates the newest interface applications allowing the program to be used through multiple avenues. Multiple avenue intervention allows the student athletic trainer to use MICAL as an supplement to traditional teaching methods; it also provides the certified athletic trainer an immediate reference source (whether it be visual, auditory, or textual). MICAL enables the user to take education beyond the classroom so that learning can occur in the home and work environments. The steps which were completed for the development of MICAL included three phases: (a) Construction of models and animations of the human knee, (b) video capturing and video digitizing, and (c) construction of MICAL.

Construction of the Models and Animations of the Human Knee

Under model construction and animation, the following steps were followed: (a) construction of the models of the human knee using the Alias™ program, (b) critiques of the models by a review panel, (c) revisions of the

models, (d) development of animations of the knee using the Alias™ program, (e) critiques of the animations by the review panel, and (f) revisions of the animations.

The Alias™ program was used for the construction of the models related to the human knee. Alias™ is a program which allowed the researcher to model and animate models or images in three dimensions. This process involve three separate procedures: (a) modeling, (b) animating, and (c) rendering. Modeling was the process used to construct a particular object. Through the manipulation of spline curves, the researcher constructed realistic three-dimensional models of the knee. In addition, the researcher alternated, enhanced, and duplicated the three-dimensional imagery.

For example, modeling was employed for the construction of the medial meniscus (see Appendix C, p. 67). To complete this process, the researcher used the new curve function within Model (component of Alias) to draw a semicircle. The semicircle was then copied twice so there was a total of three semicircles. The researcher then selected a surface tool titled "skin" to apply a surface between the three original semicircles. To apply the first surface, the researcher clicked on the skin tool. The computer then directed the researcher to choose the first curve; the original semicircle was chosen. The computer then directed the researcher to choose the second curve; the semicircle directly above the original was chosen. Once completed, the computer configured a surface between the two semicircles. This was continued until there was a surface connecting each of the semicircles. Once all the surfaces were completed, the computer constructed a rudimentary form of the

medial meniscus. Through extensive manipulation of the curves, the researcher was able to construct a replica of a medial meniscus.

For the purpose of this project, the following models were constructed:

(a) bones of the knee (tibia, fibula, femur, and patella) which were modeled individually and as a group, (b) distal portion of the hamstring and quadriceps muscles (vastus medialis, vastus lateralis, vastus intermedius, rectus femoris, semimembranosus, semitendinosus, biceps femoris, tensor fascia latae, gracillias, and the sartorius) was modeled individually and as a group to show their points of insertion around the knee, (c) the proximal portion of the gastrocnemius, soleus and popliteal muscles were modeled individually and as a group to show their points of insertion around the knee, (d) menisci of the knee (the medial and the lateral) were modeled individually and also with the tibia to show how they articulate with the bone, (e) ligaments of the knee (anterior and posterior cruciate, medial and lateral collateral, medial and lateral pateller retinaculum) were displayed individually and as a group to show their particular origins and insertions, and (f) the joint capsule as a whole and as a segment was displayed to show its function within the knee. The researcher referred to specific references for the design of the models (Nutter, 1986; Feagin, 1989).

The Alias™ program was also employed for animation of the knee. This portion of the program was used to animate the models of the knee. In addition, particular lights which were assigned to the knee were animated to give the appearance of movement.

For the MICAL project, the following animations were constructed: (a)

each muscle involved in moving the knee joint, (b) each ligament supporting the knee joint (this animation showed how each individual ligament supports the knee through various movements), (c) the function of the medial and lateral menisci during knee movement, (d) various injuries to the anterior cruciate ligament, (e) various injuries to the posterior cruciate ligament, (f) various injuries to the medial collateral ligament, (g) various injuries to the lateral collateral ligament, (h) various injuries to the medial meniscus, and (i) various injuries to the lateral meniscus (see Appendix D, pp. 68-69).

Video Capturing and Video Digitizing

Video capturing and video digitizing to QuickTime movies consisted of the following steps: (a) videos were taken of various assessment techniques and surgical treatments of the human knee, (b) movies were critiqued by experts in the field, (c) video retakes were revised, (d) movies were converted to QuickTime movies using Adobe Premiere™, and (e) QuickTime movies were critiqued by experts in the field.

The researcher videotaped fundamental assessment techniques which are used to evaluate the anatomical structures as related to potential knee injuries. These tests consisted of the following: (a) anterior drawer test, (b) posterior drawer test, (c) Lauchman's test, (d) varus stress test, (e) valgus stress test, (f) pivot shift test, (g) bollatman test, (h) patella grind test, (i) apprehension test, (j) quadriceps strength test, (k) hamstring strength test, (l) gastrocnemius test, and (m) girth measurements. Three individuals assisted in videotaping: two served as models, Dr. Kersey and Kerrilynne Plumlee, and one served as an examiner, Dr. Ransone. The above individuals agreed to sign

a consent form to participate in the video taping portion of MICAL (refer to Appendix E, pp. 70-71). These tests were videotaped on a Hi8mm camera to assure quality control. The video clips were a maximum of 30 seconds each because of space allotment. The researcher videotaped each test twice in the superior, side, and frontal positions. This allowed the researcher to choose the position which displayed each test most precisely. For the purpose of this project, only the Lauchman test and the Modified Lauchman test were incorporated into MICAL.

Next, the researcher obtained video clips that showed actual anatomical structural damage to the human knee. This portion of the program was conducted with assistance from Martin Trieb, M.D., a prominent orthopedic surgeon in the San Jose area and team physician for the Department of Intercollegiate athletics at San Jose State University. The researcher received permission from the University of Utah's School of Medicine to use surgical clips from their 1991 and 1994 surgical symposia (Appendix F, pp. 72-73). A total of 18 video clips were used to represent essential information in relation to specific injured structures. This material was selected by Martin Trieb, M.D. These videos were then converted to QuickTime movies through the Adobe Premiere™ program and incorporated as a component of MICAL. The video clips portray injured structures related to the knee.

Construction of MICAL

Finally, the MICAL program was constructed on the Macintosh™ computer using Macromind Director™. This process involved the following steps: (a) development of anatomical structures related to the knee, (b)

construction of specific injury protocols related to the knee, (c) demonstration of specific tests for evaluating injuries related to the knee, (d) evaluation of the above sections by experts in the field, and (e) revisions of the program, based upon recommendations from experts.

MICAL emphasizes the use of computers for the initiation and promotion of the learning processes. Through the combination of text, video, sound, and animation, MICAL creates an environment which stimulates ideal learning (refer to Appendix G, pp. 74-75).

For completion of MICAL, the following steps were performed: (a) the program was constructed on a Macintosh™ Quadra 840 AV (AV means it has capability to make, edit or play audio and video) with a CD-ROM drive, 16 MB of expandable memory, a 500 megabyte hard drive and a 1 GB external hard drive; (b) the program was constructed through the program Macromind Director™ (this is multimedia authoring software which allowed the researcher to construct an interactive program which utilized animation, video, sound, and text); (c) videos were edited on the Quadra 840 AV through the process of making digitized computer videos through Adobe Premier (Adobe Premier allowed the researcher to convert video into QuickTime movies; in the QuickTime format the movie can be played back in real time on the computer); and (d) the Alias™ models and animations were transferred to the Macintosh™ through a program called Debabilizer® (this program allowed the researcher to transfer the models and animations constructed on the Silicon Graphics™ workstation in the Alias™ program to the Macintosh™ computer to be used in the MICAL program).

The MICAL program consists of six different components (refer to Appendix G, pp. 74-75). These components are the following: (a) introduction, (b) directory, (c) instructions, (d) tutorial, (e) quick reference, and (f) test.

Introduction

The MICAL program begins with a 30 second introduction (with the option to exit the introduction through a click of the mouse). The introduction begins with three simultaneous animations which depict a knee injury occurring in three separate sports. The videos used for the animations were captured on a Hi8mm video camera. The videos were digitized into the computer through Adobe Premiere™. Individual frames were taken from the videos to be used in the introduction. The individual frames taken from the videos were then grouped together to make a computer animation. After completion of the three separate animations, an animation of the knee appears which rotates 360 degrees. This three dimensional animation is one of many created for the purpose of MICAL on the Silicone Graphics workstation.

Directory

According to related research (Askar et al., 1992; Guthrie & McPherson 1992; Lazarowitz & Huppert 1992; Schlechter & Bessemer 1992), the directory allows the user to make cognitive decisions which enables him or her to partake actively in a computer assisted learning program. The user can select one of the following options: (a) instructions, (b) tutorial, or (c) testing. Once the user has decided which component to review, the corresponding button is clicked which takes the user to a specific chosen destination.

Instructions

In instructions, the user learns about the MICAL program. The user has the option of hearing or reading about the program. The user learns about various situations which may arise during use of the CD-ROM. The learning components which are included in MICAL are: (a) navigational skills to move through the program effectively, (b) the audio portion of the program, (c) the video portion of the program, (d) information which is referenced in text format, and (e) the evaluation portion of the program which tests students' learning in relation to material presented in the program. In addition, the user learns how to use the quick reference portion of MICAL which provides access or reference to any portion of the program.

Tutorial

The tutorial portion of the program is the primary component of MICAL. Within tutorial, the user can access the following: (a) anatomy, (b) exploration, (c) injury assessment, and (d) injury observation (refer to Appendix G, pp. 74-75). Tutorial's interface design is based upon the human factors discussed in chapter two.

Anatomy

In the anatomy portion of the program, the user is informed about the human knee. The available information involves the muscles, ligaments, menisci and bony structures. When processing cognitive information, the user has the option of listening to the information, reading the information, and in some instances watching a video or animation about a particular structure. When the student feels comfortable with the information he or she can go to the

testing portion of the program for evaluation of anatomical knowledge (refer to Appendix G, pp. 74-75).

Exploration

The exploration component of tutorial includes three dimensional animations of the knee which rotates 360 degrees. For the development of exploration, five three dimensional animations were created on the Silicon Graphics Workstation in Alias. Each of the three dimensional animations were constructed to rotate 360 degrees. The first animation was constructed to include the following structures related to the human knee: muscles, capsular ligaments, primary ligaments, menisci, and bones. The second animation was constructed to display capsular ligaments, primary ligaments, menisci and bones. The third animation was constructed to display primary ligaments, menisci, and bones. The fourth animation was constructed to display menisci and bones. The fifth animation was constructed to display only the bony structures. The above animations were then imported into MacroMind Director™. Using the MacroMind Director, the researcher also programmed exploration to allow the user to complete any one of the following functions: (a) activate any visible structure to disclose its scientific name by using the magnifying glass cursor;; (b) execute any one of the following functions related to the animations by using the control panel : play the animations forward or backward, rewind and fast forward the animations, stop or pause the animations; and (c) remove and replace tissue layers by using the remove and replace controls, . Exploration was designed to teach the user about the appearance and shape of individual structures, the specific location of

individual structures, the relationship of one structure to another, and the origin and the insertion of structures.

Injury Assessment

In the injury assessment portion of the program, the user is shown how to properly evaluate cognitive information related to the knee. The user is able to read, listen, or observe how to evaluate the knee in its entirety or by individual components. When the student feels comfortable with the information he or she can go to the testing portion of the program to be tested on related skills and knowledge (refer to Appendix G, pp. 74-75).

Injury Observation

In the injury observation portion of the program, the user is able to learn about various injuries to the human knee. When viewing the information, the user has the option of listening to the information, reading the information, and/or watching an animation which shows how a particular structure is damaged. When the student feels comfortable with the information, he or she can go to the testing portion of the program for evaluation of skills and knowledge related to knee injuries (refer to Appendix G, pp. 74-75).

Quick Reference

The following steps were completed for the foundational work related to quick reference: (a) the interface design was developed, (b) the scrollable text fields were created, and (c) the informational components for quick reference were determined. Quick reference was not incorporated into the CD-ROM for this study. The researcher intends to include this function in the the final draft of the CD-ROM (MICAL) which will be marketed as a learning tool for

athletic trainers

Test

The test portion of the program provides the user with an opportunity to be evaluated on skills and knowledge learned. The user can choose to be tested by using any one of the following protocols: (a) auditory format, (b) text format, (c) movie format, and (d) random format (the questions are randomly selected). In addition, the user can be tested on any component of MICAL (if the student has finished learning about the anatomy of the knee and wants to be tested on the origin and insertion of all ligaments, MICAL will construct a test to evaluate the user's knowledge). Since the tests are developed from a randomized data pool, the probability of identical tests being distributed is minimal. With regards to the construction of MICAL, only the text format of test was completed.

Establishing Trustworthiness of MICAL

According to Hanson and Newberg (1992), "The trustworthiness of a study refers to how well the researcher can persuade the reader that the results are worth paying attention to" (p. 35). Thus, the researcher has to build a convincing argument that MICAL is worthy of consideration and that it is a useful educational tool for the student athletic trainer. Several researchers (Hanson & Newberg, 1992; Lincoln & Guba, 1985; and Guba, 1981) agree that to establish the trustworthiness of a study when using the naturalists' approach, four main concerns need to be addressed. These concerns are: (a) credibility, (b) transferability, (c) dependability and confirmability.

Credibility

"The naturalist views credibility in the same fashion the positivist views internal validity" (Hanson & Newberg, 1992, p. 35). To establish credibility, four processes were used: (a) member checking, (b) peer debriefing, (c) triangulation, and (d) a reflexive journal.

Member Checking

"Member checking is the process of having the researcher's construction of the data approved by the people who created it, or by experts in the field" (Hanson & Newberg, 1992, p. 35). By achieving the approval of the individual who constructed the data or by experts within the field, the researcher has established credibility for the data collected or constructed. Member checking for the MICAL program consisted of three experts within the field of athletic training and sports medicine and a minimum of 3 or more graduate students in the Department of Human Performance, San Jose State University, who reviewed the program for its trustworthiness. Specifically, the evaluation involved the following steps:

- 1) With regard to the models constructed on the Alias™ program, three experts in the field of athletic training and sports medicine (Martin Trieb, M.D., an established orthopedic surgeon in the San Jose Area; Jack Ransone, A.T.,C., Ph.D, Graduate Athletic Training Curriculum Director, Department of Human Performance, San Jose State University; and Lindsay McLean, A.T.,C., P.T., Head Athletic Trainer for the San Francisco Forty Niners) reviewed the models to determine their validity. In addition, the models were evaluated by a minimum of three athletic training graduate students in Department of Human

Performance, San Jose State University, to determine if they appeared authentic and whether they enhanced the learning process.

2) Three experts in the field of athletic training and sports medicine (Martin Trieb M.D., Jack Ransone, A.T.,C., Ph.D., and Lindsay McLean, A.T.,C., P.T.) reviewed the animations constructed on the Alias™ program to determine their validity. In addition, the animations constructed on the Alias™ program were viewed by a minimum of three athletic training graduate students in Department of Human Performance, San Jose State University, to determine if the animations authentically portrayed the movements of the knee.

3) With regards to the videos, three experts in the field of athletic training and sports medicine (Martin Trieb, M.D., Jack Ransone, A.T.,C., Ph.D. and Lindsay McLean, A.T.,C., P.T.) reviewed the videos to determine their trustworthiness. In addition, the videos were viewed by a minimum of three athletic training graduate students in Department of Human Performance, San Jose State University, to determine if the videos were clear and accurate.

4) With regard to the surgical videos, Martin Trieb, M.D. evaluated the computer replications for their accuracy. Two experts in the field of athletic training and sports medicine (Jack Ransone, A.T.,C., Ph.D. and Lindsay McLean, A.T.,C., P.T.) reviewed the surgical videos to evaluate their validity. In addition, the surgical videos were viewed by a minimum of three athletic training graduate students in Department of Human Performance, San Jose State University, to determine if the videos portrayed a clear understanding of the injured structure.

5) With regard to the MICAL program, three separate groups reviewed

the program for its trustworthiness: (a) three experts in the field of athletic training and sports medicine (Martin Trieb, M.D., Jack Ransone, A.T.,C.,Ph.D. and Lindsay McLean, A.T.,C.,P.T.) reviewed MICAL to determine its accuracy and clarity; (b) a minimum of three athletic training graduate students in Department of Human Performance, San Jose State University, reviewed the program to determine if MICAL was an effective learning tool; and (c) three experts in program design evaluated MICAL for its technical merit: Kelvin Chan, Technical Coordinator for the CADRE Institute (Computers in Art and Design, Research, and Education), School of Art and Design, San Jose State University, Cassandra Lehman, Assistant Professor in the CADRE Institute, and Joel Slayton, Director of the CADRE Institute.

Peer debriefing

Peer debriefing “is the process of exposing oneself to a disinterested peer in a manner paralleling an analytical session and for the purpose of exploring aspects of the inquiry that might otherwise remain only implicit within the inquirer’s mind” (Lincoln & Guba, 1985, p. 308). Hansen and Newberg described the purpose of peer debriefing as “exploring the inquirer’s biases, clarifying the inquirers interpretations, and generally playing the role of the devil's advocate” (Hansen & Newberg, 1992, p. 36). The peer debriefer chosen for MICAL was Robert Kersey Ph.D. A.T.,C. Dr. Kersey is the Athletic Training Specialist in the Department of Human Performance, San Jose State University. The researcher met with Dr. Kersey six times during the construction of the project. During this time, the peer debriefer evaluated notes and design plans related to MICAL that were recorded in the researcher's reflexive journal.

In addition, the peer debriefer raised questions and concerns about the accuracy and quality of MICAL.

Triangulation

Triangulation as defined by Lincoln and Guba (1985) is “. . . the use of multiple sources to obtain the same information” (p. 123). By presenting multiple sources which have matching information, the researcher's data is given more credibility. Triangulation was used in Chapter two where the researcher used multiple sources to validate particular information related to computer assisted learning, technical design and human factors. Information presented in MICAL was confirmed by two or more references cited in the literature. The MICAL program was further substantiated by triangulation through the use of five experts in the field of athletic training and sports medicine.

Reflexive Journal.

A Reflexive journal was developed and applied throughout the production of MICAL by the researcher to establish the trustworthiness of the program. “A reflexive journal is in essence a diary that is kept to record information about the researcher and about the unfolding methodology of the study” (Hanson & Newberg, 1992, p.37). According to Lincoln and Guba (1985) “a reflexive journal consists of three parts: the researcher's daily schedule and logistics of the study, a personal diary for reflection, and a methodological log in which methodological decisions and the rationale behind those decisions can be recorded” (p. 360). The researcher kept a reflexive journal on the progress of MICAL from September of 1994 until the completion of the project. The

reflexive journal was evaluated as a component of the inquiry audit.

Transferability

Transferability according to Lincoln and Guba (1985) "is the process of providing a thick description or detailed accounts of the data collected and the data analysis process" (p.124). The naturalist compares transferability to the positivist view of external validity. Hanson and Newberg (1992) further describe transferability as ". . . the process of providing enough information about the context and conditions under which the study was conducted to allow the reader to make an informed decision about whether the information presented is relevant to his or her situation" (p. 37). To further establish the trustworthiness of MICAL, the researcher used the naturalist's concept of "thick description." Thick description is the process of recording all steps involved in the development and construction of the project. In regards to thick description, the researcher provided a detailed account of the steps taken to construct MICAL. The researcher provided enough information to allow the reader to make an informed decision as to whether the program was relevant and feasible.

Dependability and Confirmability

Dependability and confirmability is the process of demonstrating that the findings and the interpretations are coherent or logically derived from the data. The naturalist compares dependability and confirmability to the positivist's notion of reliability and objectivity. According to Lincoln and Guba (1985), "Dependability and confirmability are established through the **inquiry audit**." The inquiry audit is the process of having an individual not otherwise involved

in the project, review all processes involved in construction of the project to determine whether the final product was logical and coherent. The inquiry audit was conducted by Dr. James Bryant, Chairman for the Department of Human Performance, San Jose State University.

Summary

MICAL provides the student athletic trainer with a supplement to traditional education involving multimedia interactive computer assisted learning. MICAL also provides a reference source (whether it be visual, auditory, or textual) for both the student and certified athletic trainer. MICAL brings into the classroom state-of-the-art technology which can be used in conjunction with traditional learning methods; it allows the student to control the tempo of learning and to be interactive. In addition, this project serves as a reference for the both the student and experienced athletic trainer who is unfamiliar or unclear about a specific aspect of a particular knee injury. A beneficial aspect of MICAL is that it can be used with a Macintosh™ computer, whether it be in the student's classroom, work environment, or home environment. Use of MICAL involves placing the CD-ROM into the CD-ROM drive and then being a responsive learner to a multimedia educational tool.

The steps which were completed for the development of MICAL include three phases: (a) model construction and animation on the Silicon Graphics™ workstation, (b) video capturing and video conversion into QuickTime movies, and (c) development of MICAL on the Macintosh™ computer. Model construction and animation involved the following steps: (a) construction of the models of the human knee using the Alias™ program, (b)

evaluation of the models by a review panel, (c) revisions of the models, (d) development of animations of the knee using the Alias™ program, (e) evaluations of the animations by the review panel, and (f) revisions of the animations.

Video capturing and video conversion to QuickTime movies consisted of the following steps: (a) videos were taken of various tests related to the evaluation of specific knee injuries, (b) the above videos were critiqued by experts in the field, (c) video retakes were completed on three tests for injuries to the knee, (d) movies were converted to QuickTime movies using Adobe Premiere™, and (e) QuickTime movies were critiqued by experts in the field. Finally, the MICAL program was constructed on the Macintosh™ computer using Macromind Director™. This process involved the following steps: (a) development of the tutorial section, (b) development of a quick reference section, (c) development of the testing section, (d) evaluation of the above sections by experts in the field, and (e) revisions of the above components based upon the critiques of experts in the field.

CHAPTER 4

RESULTS, CONCLUSIONS AND RECOMMENDATIONS

Summary of Results

The purpose of the construction of MICAL was to develop an educational tool for student athletic trainers which would enable them to incorporate Krahe's (1993) ideal learning environment. This state-of-the-art technology includes Silicon Graphics™, and Macintosh™ computers and their respective software. MICAL's cutting edge technology incorporates the newest interface applications allowing use of the program through multiple avenues. Multiple avenue intervention allows the student athletic trainer to use MICAL as an aid for traditional teaching methods and as an immediate reference source (whether it be visual, auditory, or textual). MICAL's' cutting edge technology enables the user to take education out of the classroom; it provides an environment where learning can occur at home or in the work environment. The steps which were completed for the development of MICAL included three phases: (a) construction of the models and animations of the human knee , (b) video capturing and video digitizing, and (c) construction of MICAL.

Construction of the Models and Animations of the Human Knee

Under model construction and animation, the following steps were followed: (a) the models of the human knee were constructed using the Alias™ program, (b) the models were critiqued by a review panel, (c) the models were revised accordingly, (d) the animations of the knee were developed using the Alias™ program, (e) the animations were critiqued by the review panel, and (f) the animations were revised accordingly.

The construction of models of the human knee took a total of 9 months. The creation of the knee involved the following structures: (a) muscles, (b) ligaments, (c) menisci, and (d) bones. The first draft of the knee was completed in the winter of 1994. The models were then critiqued by Martin Trieb, M.D., Lindsay McLean, P.T., A.T.,C. and, Jack Ransone Ph.D, A.T.,C. The following alterations of the models as recommended by the evaluators were completed:

1. The original three dimensional model of the femur was corrected because it resembled a cylinder in its appearance, whereas the real femur shaft consists of numerous curves and indentions
2. The original model of the tibia was too round in its appearance; the tibia was corrected flattening the anterior medial boarder and making the posterior boarder more oblong in shape.
3. The model of the medial menisci was corrected to make it more C shaped in appearance.
4. The model of medial collateral ligament was widened and the origin and insertion were repositioned.
5. The muscles were corrected to look more authentic and their origins and insertions were realigned.

Next, the following animations include functions of structures involving knee movement: (a) biomechanics of the knee (this animation showed how each individual ligament supports the knee through various movements), (b) function of the anterior cruciate ligament, (c) function of the posterior cruciate ligament, (d) function of the medial collateral ligament, (e)

function of the lateral collateral ligament, and (f) function of the menisci. (see Appendix D, p. 69).

The researcher found it difficult to animate the structures initially. The first set of animations were critiqued by graduate students in the CADRE Institute at San Jose State University. After the initial critique, the researcher determined that the following changes would improve the animations: (a) the structural deformation component of Alias™ was used to make movement of the structures appear more authentic, (b) the inverse kinematics portion of Alias™ was employed to allow animations of the knee to move more fluidly, and (c) the proper joint stiffness for all ranges of motion (6 degrees of freedom) for the human knee were established by using the "bones command" in Alias™. After the above corrections were made, the models were reviewed by graduate students in the Department of Human Performance. The student evaluators confirmed that the model animations were both authentic and lifelike.

Video Capturing and Video Digitizing

Video capturing and video conversion to QuickTime movies consisted of the following steps: (a) videos were taken of various examinations of the human knee, (b) movies were critiqued by experts in the field, (c) video retakes were completed, (d) movies were converted to QuickTime movies using Adobe Premiere™, and (e) QuickTime movies were critiqued by experts in the field.

The researcher videotaped fundamental assessment techniques which are used to evaluate the anatomical structures as related to potential knee injuries. For quality control these tests were videotaped on a Hi8mm camera. The total number of video clips recorded were 48. Three individuals

assisted in videotaping: two served as models, Dr. Kersey and Kerrilynne Plumlee, and one served as an examiner, Dr. Ransone. The researcher videotaped each test performed in the superior, anterior and frontal views. The researcher felt the multiple views would allow for superior video clips. The video clips were captured on Wednesday, February 23, 1995 between 1:30 p.m. and 5:00 p.m. During this time, a total of 76 video clips were filmed. The researcher supplemented the video clips with story board diagrams and appropriate scripts. The video clips ranged from 16 seconds to 30 seconds in length. Dr. Ransone evaluated the clips for authenticity and instructional value and Kelvin Chan evaluated them for technical merit. It was determined that the video clips were satisfactory and therefore retakes were not required. For the purpose of this project, only the Lauchman and the Modified Lauchman tests were incorporated into MICAL.

Next, the surgery video capturing was conducted with agreement by the University of Utah's School of Medicine (see Appendix F, pp. 72-73). The researcher, with agreement from the University of Utah's School of Medicine, used two of the Universities' video symposia tapes. There were a total of nine video clips taken from the symposia tapes. The video clips were used because they portrayed an accurate appearance of the injured structures related to the knee. The researcher then consolidated the surgical clips into QuickTime movies to display the injuries as components of MICAL. The video clips were then converted to digitized movies through a program called Adobe Premiere™. Adobe Premiere™ was used instead of QuickTime because the researcher was able to edit the movies as needed. The video clips were converted to

QuickTime movies and then critiqued. The following changes were made based upon recommendations from experts in the field:

1. The fade in and fade out portions of the video clips were removed to save memory. These portions of the video clips resulted in 6 seconds of video. When converted to QuickTime movies these six seconds of fading in and fading out resulted in 10 megabytes of disk space per movie digitized.

2. When the videos were first converted to QuickTime movies, they were compressed under the following settings: (a) video format, (b) quality level was a 100 percent, (c) 30 frames per second, and (d) unrestricted data transfer speed. With the above compression setting, the QuickTime movies ranged in size from 16 MB to 32 MB. Due to the size of the movies (megabyte size), the playback rate on the computer was slow which resulted in choppy viewing of the movie. Therefore, the researcher re-digitized the movies under a different compression setting. The different compression setting was as follows: (a) the movies were digitized in the Cinepak format, (b) the capture rate was 15 frames per second, (c) the quality level was lowered to 75 percent, and (d) the data transfer rate was changed to 185 kps second. With this variation in the digitizing of the video clips, the movie size averaged about 750 KB. As a result of the above changes, the QuickTime movies were more fluent and clear.

MICAL: CD-ROM

The MICAL program was constructed on the Macintosh™ computer using Macromind Director™. This process involved the development of the following components: (a) directory, (b) instructions, (c) tutorial, and (d) test (refer to Appendix H, p. 76-150).

The research paper displays a sample of graphics available in MICAL. Representative graphics of MICAL are displayed for the following components: (a) directory, (b) instructions, (c) tutorial, (d) quick reference, and (e) test. These graphics do not capture motion, audio or a complete three dimensional perspective of the animations; however, these dimensions are captured in the researcher's CD-ROM. The CD-ROM was burned in July of 1995 as the final step of the researcher's project (Appendix H, (pp. 76-150).

Introduction

The MICAL program begins with a 30 second introduction (with the option to exit the introduction through the click of the mouse) showing three animations of individual injuries in three sports: baseball, basketball, and soccer. The animated knee has the capacity to revolve 360 degrees; the screen will then gradually fade to black. When the revolution is completed, the user is guided to the directory. At any phase of the introduction, the user can exit and enter the directory by clicking the mouse button.

Directory

The directory allows the user to make cognitive decisions which enabled him or her to partake actively in MICAL. The user is able to select one of the following options: (a) instructions, (b) tutorial, (c) quick reference, or (d) testing. Appendix H portrays a graphic design from the CD-ROM which illustrates the above options (refer to Appendix H, p. 76).

Instructions

The instructions option allows the user to learn about MICAL. The learner is exposed to the various functions within the program. The learning

components included in MICAL are: (a) navigational skills to move through the program effectively, (b) audio description of pertinent information related to MICAL, (c) visual illustrations of information presented in MICAL, (d) information which is referenced in the text format, and (e) evaluation of the students learning in a test format. Appendix H displays an image of Instructions from the CD-ROM; this component is pertinent to the operational functions of MICAL. This image shows what the Instructions component looks like in the CD-ROM (refer to Appendix H, p. 77).

Tutorial

Tutorial portion of the program is the primary component of MICAL which includes the following: (a) anatomy, (b) exploration, (c) injury assessment, and (d) injury observation. Appendix H portrays an image of the above tutorial components (p. 78). The above components of Tutorial are presented in two different manners: systematic learning and exploration. Systematic learning is represented in the CD-ROM through sequential graphics and corresponding text for all structures related to the human knee. The exploration component involves a 360 degrees rotation of the structures to provide a complete three dimensional prospective of the knee. The systematic learning component was incorporated into the CD-ROM for the purpose of this study. The exploration (rotational) component will be included in the final draft of the CD-ROM.

Anatomy

The anatomy portion of MICAL displays sequential graphics and text for the following structures: (a) muscles, (b) ligaments, (c) menisci, (d) bones.

The origin and insertion for the above structures of the knee are displayed in scrollable text. Appendix H displays a sample of three dimensional graphics in MICAL (pp. 80-106).

Exploration

Exploration allows the user to remove the following layers of the knee joint: (a) muscles, (b) capsular ligaments, (c) primary ligaments, (d) menisci, and (e) bones . The exploration component as presented in the CD-ROM portrays a 360 degrees rotation of all related structures of the knee. Images displayed under tutorial exploration show the following structures: (a) muscles (quadriceps, hamstrings, gastrocnemius, gracillias, sartorius, tensor fascia latae, and soleus), (b) capsular ligaments, (c) primary ligaments (anterior cruciate, posterior cruciate, medial collateral, lateral collateral, (d) medial and lateral menisci, and (e) bones (tibia, fibula, patella, and femur). Appendix H portrays still three-dimensional graphics from the CD-ROM involving muscles, ligaments, joint capsule, menisci, and bones for the following degrees of rotation: (a) zero degrees, (b) 90 degrees, (c) 180 degrees, (d) 270 degrees, and (e) 360 degrees (refer to Appendix H, pp. 107-132).

Injury Assessment

In the injury assessment portion of the program, the user is shown how to properly evaluate injuries to the knee (refer to Appendix H, pp. 133-138). The CD-ROM includes the following components related to injury assessment: (a) history, (b) inspection, (c) palpation, and (d) functional tests. Although 52 functional tests were video taped only the Lauchman and Modified Lauchman tests were incorporated into the CD-ROM for this study; however,

the researcher intends to include additional functional tests from the 52 that were videotaped in the final draft of the CD-ROM which will be marketed as a learning tool for athletic trainers.

Injury Observation

In Injury Observation, the user has the capacity to study 16 different mechanisms of injury to the human knee (refer to Appendix D, p. 69). The CD-ROM also includes three dimensional animations of injuries and surgical videos. The three dimensional animations in the CD-ROM show injuries to all ligaments of the knee. Appendix H displays still images of various three dimensional animations available in the CD-ROM. These individual images show the following: (a) an anterior view of a medial collateral ligament injury, (b) a posterior view of a medial collateral ligament injury, (c) an anterior view of an anterior cruciate ligament injury, and (d) an anterior view of a lateral collateral ligament injury (refer to Appendix H, pp. 140-142). Appendix H also displays individual images of three dimensional animations which show the function of the four primary ligaments of the knee in the following views: (a) posterior view, (b) anterior view, and (c) posterior lateral view (refer to Appendix H, pp. 143-144). Finally, Appendix H displays individual images of injured structures from surgical video clips (refer to Appendix H, pp 145-147).

Quick Reference

Quick Reference will be included as a component in the final CD-ROM to be marketed as a learning tool for athletic trainers. For the purpose of this study, Quick Reference is identified as a function within the directory section, however, it was not incorporated as an active component in the CD-

ROM (refer to Appendix H, p. 76). The researcher did however complete foundational work for the Quick Reference component (refer to Appendix H, p. 148).

Test

This component of the CD-ROM provides the user with an opportunity to be tested on skills and knowledge related to the human knee. For the purpose of this project, questions were created to test the user on information related to injury assessment, structure identification, and the origin and insertions of structures (refer to Appendix H, pp. 149-150). The researcher intends to further develop this data base by developing additional test questions for all components of MICAL. In addition, the researcher intends to add the following dimensions to the test portion of MICAL: (a) audio, (b) video, and (c) graphical animations.

Peer Debrief

For the purpose of establishing the validity of MICAL, Robert Kersey, Ph.D in Education, was chosen as the debriefer. The writer met with the debriefer six times. During this time, the debriefer read the researcher's reflexive journal. After evaluating the researcher's notes and program design, the debriefer examined the progress of MICAL to determine if MICAL's design was consistent with what the researcher stated in the journal. The meetings with the debriefer allowed the researcher to stay on track with the development of MICAL. In addition, the quality of MICAL was constantly monitored by the debriefer.

In the first meeting, the researcher and Dr. Kersey discussed Chapter

three of the thesis. During the discussion two key points were addressed: (a) clarifying whether a trade mark symbol was necessary when identifying a product name or company name, and, (b) clarifying the role and title of the individuals involved in member checking.

During the next meeting, the debriefer looked at the three-dimensional models created in Alias™. Based upon the discussion that evolved the following changes were made: (a) the shaders for the muscles were readjusted to appear more authentic, (b) the tendons were readjusted so they did not dissect other structures, and (c) the writer researched how to make structures move realistically before creating the animations.

In meeting number three, the debriefer critiqued the QuickTime movies involving assessment techniques to evaluate knee injuries. The debriefer's evaluation resulted in the following changes: (a) the fade in and fade out portion of the movies were eliminated to free up memory, and (b) sound or text was added to video displays to provide educational information

In meeting number four, the debriefer examined the animation of the models which were created in Alias™. Based upon the debriefer's recommendations the following decisions were made: (a) the animations of the models were accepted with no revisions, and (b) the animations were rendered in the anterior, posterior and side views to provide the user with a three dimensional view.

The fifth meeting consisted of showing the debriefer the new models and animations of the knee. Based upon the debriefer's recommendations, the following decisions were made: (a) the animations of the models of the

epidermal layers of the knee were accepted as accurate and realistic, and (b) the epidermal animations of the knee were rendered in the anterior, posterior, and side views to provide the user with a three dimensional perspective.

Auditor

The auditor (Dr. James Bryant) evaluated the researcher's paper as well as a videotape involving various segments and components of MICAL. The objectives of the audit were twofold: (a) to determine if an audit trail was apparent throughout each chapter of the research paper and the MICAL CD-ROM, and (b) to determine if the methodology and findings in relation to MICAL were logical and coherent. The auditor's evaluation resulted in the following recommendations:

- 1) The primary and secondary objectives of the study should be clearly identified under the statement of the problem in chapter one.
- 2) The body of the text in chapter three should be consistently described in chronological order. In addition, the methodological steps used in creating MICAL should be consistently and chronologically displayed in the flow chart shown in Appendix G (pp. 73-74).
- 3) All charts and graphics in Appendix H (pp. 75-147) should be described or summarized in the body of the research paper.
- 4) Learning theories applied in creating MICAL should be identified in chapter four to reflect a more obvious audit trail between chapter two and chapter four of the research paper.

The researcher completed all recommendations extended by the auditor. After completion of the above recommendations, the auditor concluded

that MICAL was developed in a logical and coherent manner. The auditor also concluded that the methodological steps employed in the development of the CD-ROM were reliable and valid. Lastly, the auditor determined that there was an audit trail throughout the research paper related to MICAL.

CONCLUSIONS

The researcher created a reliable and valid Multimedia Interactive Computer Assisted Learning (MICAL) program by incorporating various learning theories documented in the review of literature. The following examples support this conclusion:

1) While learning any single component of MICAL, students can disengage from the computer for the purpose of reviewing, reflecting, problem solving or decision making. This method supports Krahe's (1993) theory of learning.

2) After reviewing the Lauchman and Modified Lauchman tests from a visual and auditory perspective in MICAL, students can disengage from the computer to practice the proper method of manipulation by having students serve as clients. This process allows students to become kinesthetic learners; it also implements Draper's (1987, 1989) theory of learning.

3) Students can stop any phase or component of the MICAL program. For example, when involved with the anatomical phase, students can stop or disengage from the computer for any of the following reasons: (a) to study the superior and inferior boarder of the patella (or any other image) that appears on the monitor in the pause mode, (b) to move backward in the program to review the origin and insertions of structures, (c) to move forward in the program to be

tested on the previous information related to anatomical structures and their functions. The above procedures support Johnson and Grover's (1993) theory related to learner control; it also supports their belief that feedback and repetition is important to the users' retention of information.

4) MICAL allows the user to navigate throughout the program. For example, the user can move forward or backward within the knee exploration component to study or review various structures related to the knee, be it muscles, ligaments, menisci, or bones. This process can be used for understanding the appearance and shape of individual structures, the specific location of individual structures, the relationship of one structure to another, and the origin and the insertion of structures. Also, this method of interacting with the computer provides the user with opportunity for repetition, practice, feedback, and reflection, all of which are important for successful learning (Johnson and Grover, 1993; De Jong et al., 1992).

In addition, the learner can use the "Go" function of MICAL to leave knee exploration and move to another section of the program. For example, after observing and studying the medial collateral ligament, the user can move to injury observation to examine the appearance of an injured medial collateral ligament caused by a valgus force. The learner can then use problem solving techniques to determine the mechanism of injury and type of movement executions within various sports which are likely to cause such injuries (De Jong et al., 1992; Lave, 1988; Rogoff, 1984; Krahe, 1993)

5) A sample population was used during the development of MICAL to prevent poor interface design. Prototypes of MICAL were tested by small

sample populations to determine the programs usability. This method was used to prevent carelessness, ignorance, or neglect by the researcher during the development of MICAL. The above process implemented for evaluating MICAL is supported by the research conducted by Grudin (1991) and Brown and Simpson (1994).

6) MICAL is a reliable and valid learning tool that can be used to supplement traditional education in athletic training. The methodological steps employed for creating MICAL's program follow the naturalist's approach for conducting qualitative research as documented by Lincoln and Guba (1985).

RECOMMENDATIONS

Future research to be conducted for the enhancement of MICAL include: (a) incorporating video clips of all functional tests available for the evaluation of knee injuries, (b) refining the lettering and method of identifying structures so that the user can observe each structure with precision and aesthetic appeal, (c) constructing additional tests for evaluating students' skills and knowledge related to each component of MICAL, (d) refining the audio component of MICAL, (e) improving the ease of using the CD-ROM, and (f) improving the interface design of MICAL. Lastly, the researcher intends to expand the MICAL program to include other athletic injuries and related structures of the human body.

Summary

MICAL, with its technology, provides the student athletic trainer with a supplement to traditional education involving multimedia and interactive learning. MICAL also provides a reference source (whether it be visual,

auditory, or textual) for both the student and the experienced athletic trainer. MICAL brings into the classroom state-of-the-art technology which can be used in conjunction with traditional learning methods; it allows the student to control the tempo of learning and to be interactive. An attractive feature of MICAL is that it can be used with a Macintosh™ computer, whether it be in the student's classroom, work environment, or home environment. Use of MICAL involves placing the CD into the CD-ROM drive and then being a responsive learner to a multimedia teaching or educational tool.

The steps which were completed for the development of MICAL include three phases: (a) model construction and animation on the Silicon Graphics™ workstation, (b) video capturing and video conversion into QuickTime movies, and (c) development of MICAL on the Macintosh™ computer. Model construction and animation involved the following steps: (a) construction of the models of the human knee using the Alias™ program, (b) evaluation of the models by a review panel, (c) revisions of the models, (d) development of animations of the knee using the Alias™ program, (e) evaluations of the animations by the review panel, and (f) revisions of the animations.

Internal validity was established through member checking, peer debriefing, triangulation, and a reflexive journal. External validity was established through a "thick description" or detailed account of data collected and analysis related to the development of MICAL. Finally, reliability was determined through an inquiry audit and reflexive journal. The above methodology is a reflection of the naturalist's approach toward qualitative

research as documented by Lincoln and Guba (1985).

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Appendix A

Guidelines to be Eligible for NATA Certification

Currently there are two ways to become NATA certified:

(a) completing a Bachelors degree from a college that has a NATA approved curricula and passing the NATA Examination, and (b) completing an internship and passing the national examination.

The following course work is required for both curriculum route and internship options: (a) human anatomy, (b) human physiology, (c) exercise physiology, (d) kinesiology or biomechanics, (e) nutrition psychology, (f) personal and community health, (g) prevention and care of athletic injuries and illnesses, (h) evaluation of athletic injuries and illnesses, (i) first aid and emergency care, (j) therapeutic modalities, (k) therapeutic exercise (l) administration of athletic training programs, and (m) instructional methods.

For an individual who prepares for the certification examination via the Internship option, the following additional course work is required: (a) basic athletic training, and (b) advanced athletic training.

In addition to the above requirements, a candidate is required to complete a minimum number of clinical hours. For the curricula approved program, the individual must perform 700 clinical hours with 25% of those hours coming from a collision sport. For the internship program, a candidate must perform a minimum of 1500 hours with 25% of those hours coming from a collision sport. Furthermore these hours must have been acquired within five years prior to taking the certification examination.

Appendix B

The Role of NATA

The national athletic trainer's association was organized in 1950 to serve the following purposes:

1. To enhance the quality of health care for the physically active.
2. To advance the profession in prevention, evaluation, managements, and rehabilitation of injuries
3. To safeguard and advance the interests of its members by:
  - (a) presenting the profession's viewpoints, concerns, and other important information to the media, (b) appropriating legislative, administrative, regulatory, and private sector bodies, and (c) developing a working relationship with appropriate governmental and private sector (profit and nonprofit).
4. To advance members' level of knowledge through the collection, interpretation, and dissemination of information on subjects appropriate to the profession.
5. To engage in a any lawful act or activity for which a corporation may be organized under the nonprofit corporation law.

Appendix C

Example of Building a Model of a Meniscus in Alias™**Step 1**

A semicircle is drawn using the new curves function.

Step 2

original
semicircle

2 copies of the
semicircle

Two copies are made of the original semicircle.

Step 3

The first copied semicircle is moved 1 cm above the original. The second semicircle is reduced in size and moved 3 cm in front of the original.

Step 4

By using a surface tool titled skin, a surface is applied between each of the semicircles. A,B, and C, of step 4 shows how the skin is applied between each of the semicircles. D of step 4 shows what the final product would look like.

Appendix D

Models and Animations Constructed in Alias™**Muscles Models**

1) Quadriceps muscles

- a) Vastus Lateralis
- b) Vastus Medialis
- c) Vastus Intermedius
- d) Rectus Femoris

2) Hamstring Muscles

- a) Semimebranosus
- b) Semitendinosus
- c) Biceps Femoris

3) Gracillias

4) Sartorius

5) Tensor fascia latae

6) Gastrocnemius

7) Soleus

Ligaments

Origin of Anterior Cruciate Ligament (ACL)

Front

Back

Insertion of ACL

Front

Back

Origin of Posterior Cruciate Ligament (PCL)

Front

Back

Insertion of PCL

Front

Back

Origin of Lateral Collateral Ligament (LCL)

Front

Back

Insertion of LCL

Front

Back

Origin of Medial Collateral Ligament (MCL)

Front

Back

Insertion of MCL

Front

Back

Origin of the Ligament of Wrisberg

Front

Back

Insertion of the Ligament of Wrisberg

Front

Back

Origin of the Ligament of Humphry

Front

Back

Insertion of the Ligament of Humphry

Front

Back

Menisci Models

Medial Menisci

Top

Front

Back

Lateral Menisci

Top

Front

Back

Bones Models

Frontal View

Posterior View

Medial View

Lateral View

Normal intercondylar notch

A Shaped intercondylar notch

Normal Femoral Patellar Groove

Abnormal Femoral Patellar Groves

Appendix D continued

Models and Animations Constructed in Alias™**Function of Structures Involving Knee Movement**

- 1) Biomechanics of the Knee
(a) Frontal (b) Posterior (c) Medial (d) Lateral
- 2) Functions of the Anterior Cruciate Ligament
(a) Frontal (b) Posterior (c) Medial (d) Lateral
- 3) Functions of the Posterior Cruciate Ligament
(a) Frontal (b) Posterior (c) Medial (d) Lateral
- 4) Functions of the Medial Collateral Ligament
(a) Frontal (b) Posterior (c) Medial (d) Lateral
- 5) Functions of the Lateral Collateral Ligament
(a) Frontal (b) Posterior (c) Medial (d) Lateral
- 6) Functions of the Menisci
(a) Frontal (b) Posterior (c) Medial (d) Lateral

Mechanisms of Injuries Using the Modeled Leg

- 1) Varus contact with out rotation
- 2) Valgus contact with out rotation
- 3) Varus contact with rotation
- 4) Valgus contact with rotation
- 5) Blow to the tibial tubercle or fall on flexed knee
- 6) Non contact hyperextension
- 7) Non contact deceleration
- 8) Non contact deceleration with tibial medial rotation or femoral lateral rotation
- 9) non contact, quick turning one way with tibia rotated in opposite rotation
- 10) Non contact, rotation with varus or valgus stress
- 11) Non contact compressive rotation
- 12) Hyperflexion
- 13) Forced medial rotation
- 14) Forced lateral rotation
- 15) Flexion-varus medial rotation
- 16) Flexion varus lateral rotation

Appendix E

Release Form to be Used in the Video Taping Portion of MICAL

A campus of California State University

College of Applied Sciences and Arts Department of Human Performance
One Washington Square San Jose, California 95192-0054 408/924-3010 • Fax 408/924-3053

Consent Form**STATEMENT OF AGREEMENT FROM PARTICIPANTS**

I _____ give permission to Gregg Robert Gould, a graduate student in the Department of Human Performance at San Jose State University to use video images of myself (which Gregg Gould video taped) in the CD-ROM MICAL. My video images will be used to teach athletic trainers how to perform various functional tests for assessment of possible knee injuries. I

_____ understand that there is no monetary commitment by Gregg Gould to reimburse me for either the time spent capturing my video images or for royalties from the CD-ROM which is to be published as a learning tool. I understand that there will be no physical risk or psychological harm to myself while the video taping occurs.

- 1) The researcher anticipates that the subjects are at no risk during the above procedures.
- 2) Questions about the research project may be addressed to Gregg Gould, principle investigator. Complaints about the research may be presented to Dr. James Bryant, Chair, Department of Human Performance, San Jose State University (408/924-3010). Questions or or complaints about the research project, subjects rights, or a research related injury may be presented to Serena Stanford, Ph.d., Associate Academic Vice President for Graduate Studies and Research, at (408) 924-2480.
- 3) If a subjects chooses to "not participate" no service of any kind to which he or she is other wise entitled will be lost or jeopardized

Appendix E continued

Release Form to be Used in the Video Taping Portion of MICAL

A campus of California State University

College of Applied Sciences and Arts Department of Human Performance
One Washington Square San Jose, California 95192-0054 408/924-3010 • Fax 408/924-3053

Consent Form continued**AGREEMENT TO BE USED IN MICAL**

- 4) A subject may refuse to participate in the study or in any part of the study. If a subject decides to participate in the study, he or she is free to withdraw at any time without prejudice to the subject's relation to San Jose State University or any other participating institutions.
- 5) The subject will receive a signed and dated copy of the consent form.

Subject's Name

Subject's Signature

Date

Researcher's Name

Researcher's Signature

Date

Appendix F

Release From the University of Utah

A campus of California State University

College of Applied Sciences and Arts Department of Human Performance
One Washington Square San Jose, California 95192-0054 408/924-3010 • Fax 408/924-3053

AGREEMENT TO REPRODUCE MATERIAL IN MICAL

The University of Utah School of Medicine gives permission to Gregg Robert Gould, a graduate student in the Department of Human Performance, San Jose State University, to reproduce portions of the videos which were used in Arthroscopic Surgery symposia 1990 and 1994. The reproductions will be used in an interactive learning program. The function of the video clips are to educate the user about how structures can be injured during sports related activities. The University of Utah School of Medicine will be given full recognition within MICAL for the video clips which were used.

Name of Authorizing Individual

Signature of Authorizing Individual

Date

Name of Research

Signature of Researcher

Date

Appendix F continued

Release From the University of Utah ARTHROSCOPIC SURGERY
SEMINARS• Robert W. Metcalf, M.D. •
Memorial*February 23, 1995*

*San Jose State University
College of Applied Sciences and Arts
Attention Professor Barbara Conry
FAX # 408/924-3053*

Re: Gregg Gould

To Whom It May Concern:

In response to a request to use clips from videotapes of past Arthroscopic Surgery meetings for Mr. Gould's Masters Thesis Project, I have signed the accompanying consent form. I am very interested in receiving a copy of the completed project.

I shall look forward to hearing from you.

Best Regards,

*E. Marlowe Goble, M.D.
Chairman*

KAS

Enc.

Appendix G
Flow Chart of MICAL

Appendix G continued

Flow Chart of MICAL

Graphical Designs from MICAL: CD-ROM

DIRECTORY

The directory is the beginning of MICAL. It allows the user to choose from the following: (a) instructions, (b) tutorial, (c) test, and (d) quick reference.

Graphical Designs from MICAL: CD-ROM

DIRECTORY: INSTRUCTIONS

The instruction portion of MICAL allows the user to learn the important components and functions of the CD-ROM. Also, the user is able to access this section of MICAL at any time if a question arises on how to use the program.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

DIRECTORY: TUTORIAL

The tutorial portion MICAL allows the user to extract information through systematic learning or exploration. The user can choose from the following components:

(a) anatomy, (b) exploration, (c) assessment, (d) observation.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY**

The anatomy portion of tutorial is designed to allow the user to learn about structures and functions of the knee in a systematic manner. The user has the option to choose from tutorial (the systematic learning) or exploration.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY**

The following categories comprise the significant structures of the knee:

(a) muscles, (b) ligaments, (c) menisci, and (d) bones.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - MUSCLES**

Systematic muscle anatomy educates the user on the following significant information: (a) origin, (b) insertion, and (c) function. The user is presented material in the following formats: (a) audio, (b) video, (c) text, (d) graphical animation, and (e) graphic images.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - MUSCLES**

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - MUSCLES

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - MUSCLES

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - MUSCLES

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - MUSCLES

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - LIGAMENTS**

Systematic ligament anatomy educates the user on the following significant information: (a) origin, (b) insertion, and (c) function. The user is presented material in the following formats: (a) audio, (b) video, (c) text, (d) graphical animation, and (e) graphic images.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - LIGAMENTS

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - MENISCI**

Systematic menisci anatomy educates the user on the following significant information: (a) origin, (b) insertion, and (c) function. The user is presented material in the following formats: (a) audio, (b) video, (c) text, (d) graphic animation, and (e) graphic images.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - MENISCI

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - MENISCI

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee. By clicking on the down arrow the user replaces the text on the screen with additional text. By clicking on the up arrow, the user replaces the current text with previously viewed text.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: ANATOMY - MENISCI

The Function and Origin/Insertion scroll menus allow the user to read information pertaining to prominent structures of the human knee.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - BONES**

Systematic bone anatomy educates the user on the following significant information:

(a) origin and insertion of attaching structures, (b) prominent land marks, and (c) function.

The user is presented material in the following formats: (a) audio, (b) video, (c) text,

(d) graphic animation, and (e) graphic images.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - BONES**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - BONES**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - BONES**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - BONES**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: ANATOMY - BONES**

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION

The exploration portion of tutorial allows the user to explore the knee at his or her own pace. The key components of exploration are: (a) anatomy, (b) knee exploration, and (c) injury observation and assessments.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - MUSCLES

View of the human knee at 0 degrees.

Exploration allows the user to use a magnifying glass to explore each structure associated with the knee. When the magnifying glass clicks on the structure, the name of the structure appears for the user in blue text. For Appendix H, only frames 1, 2, and 4 of exploration will show the blue text which identifies the structures.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MUSCLES** **View of the human knee at 90 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MUSCLES** **View of the human knee at 180 degrees.**

TUTORIAL: EXPLORATION - MUSCLES

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MUSCLES** **View of the human knee at 360 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - LIGAMENTS (Joint Capsule)

View of the human knee at 0 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - LIGAMENTS (Joint Capsule)

View of the human knee at 90 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - LIGAMENTS
(Joint Capsule)** **View of the human knee at 180 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - LIGAMENTS
(Joint Capsule)** **View of the human knee at 270 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - LIGAMENTS (Joint Capsule)

View of the human knee at 360 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - LIGAMENTS

View of the human knee at 0 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - LIGAMENTS** **View of the human knee at 90 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - LIGAMENTS** **View of the human knee at 180 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - LIGAMENTS

View of the human knee at 270 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - LIGAMENTS** **View of the human knee at 360 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MENISCI** **View of the human knee at 0 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MENISCI**

View of the human knee at 90 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MENISCI** **View of the human knee at 180 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MENISCI**

View of the human knee at 270 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - MENISCI**

View of the human knee at 360 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - BONES

View of the human knee at 0 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - BONES** **View of the human knee at 90 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - BONES** **View of the human knee at 180 degrees.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: EXPLORATION - BONES

View of the human knee at 270 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM**TUTORIAL: EXPLORATION - BONES**

View of the human knee at 360 degrees.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY ASSESSMENT

The assessment portion of MICAL includes the following: (a) history of the injury, (b) inspection of the injury, (c) palpation of the injury, and (d) function test of the injury.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY ASSESSMENT

Injury assessment allows the user to choose from the following categories: (a) history, (b) inspection, (c) palpation, and (d) functional test.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY ASSESSMENT - HISTORY

In the history portion of assessment, the user learns how to properly obtain information related to the injury so as to establish a good background of the injury.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY ASSESSMENT - INSPECTION

In the inspection portion of assessment the user learns how to properly inspect the knee joint for injuries.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY ASSESSMENT - PALPATION

In the palpation portion of assessment the user learns how to properly feel the structures of the knee joint.

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY ASSESSMENT - FUNCTIONAL TESTS

This portion of assessment allows the user to learn key functional tests which are important for evaluating the structural anatomy of the knee. For MICAL only the Lauchmen and the Modified Lauchmen test are available in MICAL.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY OBSERVATION

The injury observation portion of tutorial allows the user to learn both a visual and/or auditory perspective regarding injured structures to the human knee.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: INJURY OBSERVATION -
THREE DIMENSIONAL ANIMATIONS****View A** **View B**

The two frontal views of the knee are three dimensional animations which show injuries that can occur to the human knee. View A shows how the medial collateral ligament is injured when valgus force is applied. View B shows an injury to the lateral collateral ligament when a varus force is applied.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: INJURY OBSERVATION -
THREE DIMENSIONAL ANIMATIONS**

This frontal view of the knee is one of multiple three dimensional animations which shows how the medial collateral ligament is injured when a valgus force is applied.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: INJURY OBSERVATION -
THREE DIMENSIONAL ANIMATIONS****View A** **View B**

The two frontal views of the knee are three dimensional animations which show injuries that can occur to the human knee. View A shows how the leg looks before a verus force is applied. View B shows what happens to the leg when the verus force is applied.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: INJURY OBSERVATION -
THREE DIMENSIONAL ANIMATIONS**

An anterior view of the knee; this view shows the bones and the ligaments of the knee joint. This three dimensional animation shows the functions of the four primary ligaments of the knee. These ligaments are: (a) the anterior cruciate ligament, (b) the posterior cruciate ligament, and (c) the collateral ligaments

Graphical Designs from MICAL: CD-ROM**TUTORIAL: INJURY OBSERVATION -
THREE DIMENSIONAL ANIMATIONS**

This posterior view of a three dimensional animation showed the functions of the four primary ligaments of the knee.

This anterior view of a three dimensional animation showed the functions of the four primary ligaments of the knee.

Appendix H continued

Graphical Designs from MICAL: CD-ROM

TUTORIAL: INJURY OBSERVATION - SURGICAL CLIPS

View of a torn ACL.

View of a torn Meniscus.

View of a bucket handle tear of the meniscus.

View of a Lauchman's test.

A total of 12 video clips were used to represent essential information in relation to specific injured structures. These videos were converted to QuickTime movies through the Adobe Premiere™ program and incorporated into MICAL.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: INJURY OBSERVATION - SURGICAL CLIPS**

View of a Notch Plasty of the intercondylar notch of the femur.

View of a Posterior Cruciate ligament tear.

View of a horizontal meniscus tear.

View of a Longitudinal tear of the meniscus.

Graphical Designs from MICAL: CD-ROM**TUTORIAL: INJURY OBSERVATION - SURGICAL CLIPS**

**View of an Anterior Cruciate
Ligament tear.**

View of a Posterior Sag sign.

**View of a Pivot Shift test to
determine the stability of the
anterior capsule.**

**View of a bilateral posterior
sag test.**

Appendix H continued

Graphical Designs from MICAL: CD-ROM**DIRECTORY: QUICK REFERENCE**

The quick reference portion of MICAL allows the user to enter the program and access any information within the program which they choose to review.

Graphical Designs from MICAL: CD-ROM

DIRECTORY: TEST

The test portion of MICAL allows the user to be tested on the material which has been reviewed in MICAL's program. Ten test questions represent a sample of MICAL's data base.

Graphical Designs from MICAL: CD-ROM**DIRECTORY: TEST**