THE DEVELOPMENT AND IMPLEMENTATION OF A COMPUTER-ASSISTED INSTRUCTION SERIES TO BE UTILIZED AS AN AID TO CURRICULUM METHODOLOGY IN PHYSICAL EDUCATION

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

COLLEGE OF HEALTH, PHYSICAL
EDUCATION, AND RECREATION

BY

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DENTON, TEXAS

DECEMBER 1981

ACKNOWLEDGEMENTS

For a project of this magnitude, the persons who should be acknowledged are many; a few of them, however, deserve many thanks:

Dr. Marilyn Hinson who patiently directed this investigation to its conclusion and contributed substantially to its excellence,

Dr. Barbara Gench and Ms. Bobbie Ferrell who gave their time and energies to serve on the committee,

Dr. Jane Mott and Dr. Aileene Lockhart who gave their time and energy to serve on the committee and gave of themselves as friends to provide emotional support,

Ann Powell, JoAnne Kuhn and Betty Reid who helped just by being there,

Doris Geitgey, Dean of the School of Nursing at the University of Kansas, Dr. Sydney Krampitz, Associate Dean, Dr. Doris Geiss, Assistant Dean, Dr. Nancy Lackey, Dr. Marilyn Chard and Dr. Sue Popkess-Vawter, all of whom believed, and finally,

Mr. and Mrs. Charles J. Lease, Mr. Charles A. Lease and Mrs. Marie Fitch...my family...whose unending encouragement, total belief in my ability, support, and love was fully responsible for the conclusion of this dissertation.

DEDICATION

This dissertation is dedicated to four very significant people:

-Miss Elaine Stokes, who was the first to show me that teachers are really kind and caring people;

-Dr. Joan Nessler who first taught me academic excellence;

-Mrs. Hattie Umberger, my grandmother, the first teacher in the family who I'm sure somehow knows;

and finally,

-Dr. Boots Cooper, who, through her friendship taught me new meanings for excellence and dedication.

Thank you ladies.

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CHAPTER I

ORIENTATION TO THE STUDY

The traditional teaching-learning model within the university setting remains widely accepted even though ivy-covered buildings on the university campus now contain technology with capabilities which offer unique instructional opportunities. Indeed, pedagogy, which is at the center of a university's purpose, continues to be "the...area in which the least innovation has taken place to date" (Rockart & Scott Morton, 1975, p. 5). Faculty teaching physical education are neither more nor less guilty of the lack of innovations in teaching interventions than are educators in any other discipline.

Sanders (1977) reports several research studies which were designed to examine the effectiveness of instruction and learning in computer related educational environments. These studies indicate that computers have been used quite effectively to enhance learning (pp. 342-343). Anastasio (1974), however, identified several factors which were obstacles to the utilization of computers in higher education and placed them in three categories: economic reasons, technical reasons, and educational reasons. Anastasio stated that while the advantages of computer-assisted instruction were documented in a recent study, the most critical obstacle to more widespread educational use of the computer is the lack of available high quality computer-based educational materials. This factor became obvious when the present investigator began to search the literature for CAI (computer-assisted instruction) systems currently available. There is still a dearth of CAI systems available in physical education. Since the use of CAI programs as a tool for teaching intervention has been effective in disciplines which have programs available (Richardson, 1974, p. 43; Sanders, 1977, pp. 342-343) and since few CAI systems in physical education were available, it seemed germane to this writer to develop curriculum aids which might be added to the general set of available CAIs in this virgin field. Kinesiology, including the development of theoretical concepts and application techniques, was chosen as the academic sub-discipline to be the focus for this study. The following were reasons for this decision:

1. The nature of the sub-discipline, kinesiology, appeared to make this area of study particularly appropriate for computer utilization in both conceptual development and

application techniques.

2. At Texas Woman's University (as well as at many others) kinesiology is required of all undergraduate students in physical education, physical therapy, and occupational therapy; thus the potential of student utilization was demonstrated.

3. The subject content of kinesiology with respect to didactic content was viewed as relatively stable when compared with other sub-disciplines within the field of physical education.

4. There are no CAI materials currently available in kinesiology. Whereas it may be that all sub-disciplines in physical education ultimately should make use of this curriculum tool, the present investigation was concentrated on the sub-discipline of kinesiology.

Statement of the Purpose

The purpose of this study was to develop and implement a series of computer programs which were intended to aid students in physical education by increasing their levels of expertise in a particular area of specialization. Specifically, the program series was directed toward the undergraduate student population in the study of kinesiology.

Concomitantly, it was expected that students would develop skills in the utilization of computers and computer terminals.

Statement of the Problem

Physical education administrators are generally responsible for three functions: supervision of staff, administrative management, and curriculum development (Humphrey, Love & Irwin, 1972, p. 405). It was the third function with which this investigation was concerned.

A broad definition of curriculum development includes the development of those interventions or methods of teaching utilized by faculty members to direct learning. The utilization of computer-assisted instruction as a method of providing for individual differences and immediate reinforcement must necessarily be subtended. The specific problem of this study was to write and validate original computer-assisted instruction programs for the use of undergraduate students registered for a course in kinesiology.

Research Question

The specific question that was addressed by this investigation was:

Can a series of computer-assisted instruction programs be developed which will aid students in physical education to increase their levels of expertise in kinesiology?

Definitions and/or Explanations of Terms

For the purposes of this investigation, the following definitions and/or explanations were established.

CAI. An acronym for computer-assisted instruction.

Computer-assisted instruction. A teaching intervention which utilizes computers to supplement classroom instruction. The student is guided by a computer through a course of study aimed at achieving certain instructional goals (Sanders, 1977, p. 340).

CRT. An acronym for a cathode ray tube. The tube which forms the display for text generated by a computer. It is sometimes connected to a keyboard to create a CRT type terminal. For the purpose of this study, CRT refers to a terminal of this type.

Printing terminal. A keyboard type machine which prints student input and computer output on paper. This type of terminal differs from the CRT which provides a temporary image on a screen.

Terminal. A device which is utilized to communicate with a computer.

Kinesiology. "The knowledge of the mechanics of movement which emerge from the blending ... of human anatomy with that knowledge basic to the study of physics" (Hinson, 1981, p. 3).

Program. A series of instructions to a computer.

Limitations of the Study

The generalizability of the CAI programs developed during the course of the investigation was subject to the following limitations:

1. The acceptability of the selected programmed content to meet curriculum goals.

2. The extent to which another computer system is compatible with the DEC-System 2050 computer and the BASIC compiler utilized to generate these programs.

3. The number of interactive terminals available for student utilization on a university campus.

4. The precision of program documentation.

Delimitations

This investigation was subject to the following delimitations:

1. Female volunteers from the Texas Woman's University who were undergraduate students in a kinesiology class or graduate students enrolled in an undergraduate kinesiology course.

2. The ability of the subjects to utilize the computer system.

3. The objectivity, reliability, and validity of the techniques utilized in the collection of the evaluation data.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of related literature is presented in six sections, as follows: (a) historical overview of the development of computers (b) major contributors to CAI development, (c) CAI uses in higher education, (d) CAI uses in physical education, (e) modes of CAI, and (f) the advantages and disadvantages of CAI.

Historical Overview of the Development of Computers

"An early ... calculating device was the abacus, which, although over 2000 years old, may still be the most widely used calculator in the world" (Sanders, 1977, p. 16). Although the steps between the abacus and the high-speed electronic computer of today are varied and provide a fascinating story of the genius of man, the complete history of computers is beyond the scope of this paper. A few noteworthy events in this development are presented here to allow the reader to gain some perspective of the rapidity with which the computer industry has developed. In 1944, the Mark I was developed at Harvard University for the International Business Machine

Corporation (IBM). The Mark I was the first automatic digital computer (Baker, 1975, p. 4). "It was Eviac ... [which was] considered to be the first electronic digital computer" (p. 15). However, "To the EDSAC, finished in 1949 at Cambridge University, must go the distinction of being the first stored program electronic computer" (Sanders, 1977, p. 27). That the computer industry has grown to its present proportions in a mere 30 years is indicative of the phenomenal increase in the data gathering and data processing behavior of present-day societies. In 1950, there were 12 computers in the United States. By 1980, this number had grown to 75,000 large mainframe computers and hundreds of thousands of microcomputers (Poirot, 1980, p. 1).

From 1949 to 1960, the use of the computer in education paralleled the use of computers in business and industry in that computer utilization seemed limited to administrative and business services with a few notable exceptions. In 1954, B. F. Skinner designed a teaching machine based on the principle of programmed instruction (Baker, 1975). In the late 1950s, "Scientists used a 650 computer connected to a typewriter terminal as a dynamic Skinnerian teaching machine" (p. 18). This machine provided constant dialog with the computer and was utilized to teach IBM programmers binary arithmetic. "The way had been paved for self-instruction via the computer. Likewise the seed of an idea--time sharing--had been planted" (p. 18). With the development of the first high-level programming language (FORTRAN) in 1957 (Baker, 1975) the way was prepared for the beginning of the educational use of the computer. "In the past decade, expenditures for academic computing in higher education (research, instruction, and administration) have more than doubled," (Molnar, 1981, p. 26) reaching an estimated $1.2 billion dollars by 1981 (p. 26).

Major Contributors to CAI Development

A number of individuals and universities have made contributions to the development of computer-assisted instruction; however, for the sake of brevity, only those universities which have demonstrated a significant com-mitment to the development of computer-assisted instruction are reviewed. The first large-scale application of CAIs has developed into the national system known as PLATO. The first formal demonstration of PLATO in action occurred in November, 1960, at the University of Illinois (Lyman, 1972, p. 6). "PLATO, an acronym for Programmed Logic for Automatic Teaching Operations, offers teachers a means by which their classroom instruction can be supplemented by individualized, self-paced instruction" (Magidson, 1978, p. 15).

> Based around a large computer, the Control Data Corporation (CDC) 6400, the system is intended to have four central processors and to serve, at any one time, as many as 4,000 student terminals located ed anywhere within an 800 mile range of the computer. (Hammond, 1972, p. 39)

Since its inception, the PLATO system has grown to its present size; learning centers are maintained in 50 cities, six universities, and numerous secondary schools across the nation. PLATO offers programs in courses as diverse as aeronautical engineering and Chinese and includes coursework in electrical engineering, geometry, biology, nursing, pharmacology, and basic medical science to name a few (Bitzer & Skaperdas, 1970). Further examples of coursework available on PLATO will be addressed in subsequent sections of this review. Since 1970, a course in curriculum decision making in physical education and a course providing prerequisite instruction for Biomechanics, which are discussed later in this review, have been added to the PLATO system.

A second and much newer CAI system is the TICCIT system. An acronym for Time-Shared Interactive Computer Controlled Information Television, the TICCIT system began full scale operation in the 1975-76 academic year (Jones, 1979). The hardware for the TICCIT system was developed by the MITRE Corporation and the courseware has been developed predominately at Brigham Young University (Rockart & Scott Morton, 1975, p. 101). The TICCIT system courseware has been developed in the academic areas of English and mathematics and is geared to the community college level. "The purpose of the TICCIT project was to use minicomputers and television technology to deliver CAI lessons and educational programs in English and mathematics to community college students" (Suppes & Macken, 1978, p. 10).

In an effort to evaluate the effect of these two instructional systems, a major study was undertaken in 1975. "Two community colleges, one each in Arizona and Virginia, participated in the demonstration of the TICCIT program; and five community colleges in Illinois participated in the demonstration of the PLATO system" (Alderman, Appel, & Murphy, 1978, p. 40). Three major differences in the systems were noted. First, the PLATO system is based on a large, central mainframe, while the TICCIT system is designed as a composite unit for each school. Each TICCIT system is designed to support 128 terminals, whereas the PLATO system is designed to support as many as 4,000 terminals. Secondly, the development of courseware is a major difference between the two systems. The philosophy underlying the PLATO system is to facilitate the production of courseware by teachers and, to that end, the Control Data Corporation developed the authoring language, TUTOR, to make the production of lessons easier. "While teachers were expected to prepare PLATO lessons, teams of specialists were assembled to design, develop, and produce TICCIT courseware" (Alderman et al., 1978, p. 40). Finally, what many educators consider the most important difference, is the purpose of the two systems. The PLATO system is designed to supplement faculty instruction, while the TICCIT courseware is designed to completely supplant the instructor and provide independent instruction for entire college courses. (Alderman et al., 1978, p. 40). In evaluating the impact of the two systems, the Educational Testing Service (Princeton, N.J.) considered student achievement, student attrition, and student attitudes. "The basic finding of the evaluation in the areas of student attrition and achievement was neutral: student exposure to the PLATO system had no consistent import on either attrition or performance" (Alderman et al., 1978, p. 42). There were, in general, no significant differences in either achievement or attrition. Further, there were 18 positive and 14 negative effects among the 32 populations studied for attrition.

"Among 23 populations examined for achievement, there were 11 positive PLATO effects and 12 negative PLATO effects" (Alderman et al., 1978, p. 42). The evaluation of student attitudes revealed "PLATO students showed significantly more favorable attitudes toward computers and computer-assisted instruction than non-PLATO students" (Alderman et al., 1978, p. 42). The students identified the following as the factors they liked about PLATO instruction: (a) they could make mistakes without embarrassment, (b) PLATO made helpful comments on their work, (c) PLATO made good use of examples and illustrations, and (d) they were able to be active in their instruction. Seventy to ninety percent indicated that they would like to take further courses using PLATO (p. 42).

"There were significant TICCIT effects on both course completion rates and student achievement, but the effects occurred in opposite directions" (p. 43). "The impact of the TICCIT program on course completion rates, ... was negative in every case save one. And these negative effects were significant in 12 cases of the total of 17 cases studied" (p. 43). The evaluators differentiated course completion from course attrition to clarify this section of the evaluation. They further pointed out that "even when students pursued their studies on the TICCIT system across terms, their likelihood of completing a course did not improve" (p. 43). "The analyses conducted for student achievement were just as conclusive that the TICCIT program had a significant, positive impact" (p. 43). In mathematics, TICCIT users scored as much as 10% higher on posttest measures than did comparable students in lecture sections. Evaluation of English, produced only about a 5% difference in posttest measures, but this was nonetheless significant (p. 44). Student attitudes were evaluated generally as favorable, but less so than those of PLATO students. "Yet evaluations of the educational impact of each project revealed that neither CAI system had reached the potential so long claimed for this form of instructional technology" (Alderman et al., 1978, p. 44).

> The Computer-Assisted Instruction Laboratory of The University of Texas at Austin was initiated in June, 1965 ... as part of an overall objective of bringing the University of Texas to a position of leadership in the applications of computers to the problems of a large university. (Judd, 1972, p. 1)

"In June, 1976, the laboratory purchased the first production model of the IBM 1800/1500 instructional system to serve as an independent complement to the 1440" (Judd, 1972, p. 1). Previous CAI efforts included the development of courseware in chemistry, precalculus mathematics, English, and a prevocational training program for educable mentally retarded high school children. "During the past year, the CAI laboratory adopted a policy of concentrating its instructional efforts within the College of Education" (p. 7). Most of the education students using the system in 1972 were interacting with courseware in introductory statistics and diagnostic screening for handicapping conditions. The latter courseware (Computer-Assisted Remedial Education) was developed at the Pennsylvania State University. Other courses on the system receiving heavy usage were an Arabic writing program and the previously mentioned English punctuation and usage programs (p. 10). The future plans of the University of Texas included the development of CMI (computer-managed instruction) in the University's introductory psychology course.

> Activities ... for CAI development will probably be concentrated on instructional simulations which would allow student teachers to practice coping with a variety of classroom problems and give psychological counseling trainees valuable experience ... prior to their contact with actual clientele. (p. 12)

One of the major projects of the Pennsylvania State University's computer-assisted instruction project was the development of Computer-Assisted Remedial Education program (Judd, 1972, p. 8). "The CARE curriculum is a self-contained college level course designed to help regular classroom teachers identify children with particular mental handicaps that are likely to adversely affect their academic progress" (Suppes & Macken, 1978, p. 10).

> It covers mental retardation, emotionally disturbed and disadvantaged children, visual, hearing, speech, motor, and learning disabilities, and an introduction to testing and measurement, and documentation and referral procedures as well as a general introduction to the problems of working with exceptional children. (Judd, 1972, p. 9)

This CAI system was designed to be disseminated by a mobile van. The van, which had 16 self-contained student stations went to a different location each 17 weeks of the school year (Baker, 1976).

Other universities which have made major contributions in the field of computer-assisted instruction are Stanford University, the University of California at Santa Barbara, the University of Michigan, and the Florida State University. For the most part, these universities are developing courseware utilizing IBM's Coursewriter language. The academic disciplines receiving the most attention are mathematics, psychology, biometry, and physics (Bushnell & Allen, 1967).

CAI Uses in Higher Education

Although computers are being utilized in higher education in a variety of academic disciplines (Allee, Jr. & Williams, 1980; DeCampo, 1972; Demb, 1974; Hofstetter, 1978; Miller, 1972; Skinner & Grim, 1979; Watson, 1978) the fields of mathematics, the sciences, and the health professions have been prolific in their use of this innovative technique (Namkung, 1975). The following pages include examples of the myriad of CAI uses in these fields. An extensive reference list was compiled in the course of this investigation and is included in Appendix B for the interested reader.

CAI Uses in Mathematics

Two studies from the field of mathematics are included in this review. These studies were chosen because each represents a different subdiscipline within the field of mathematics. Also included is an example of computer-assisted instruction in fortran programming.

The first study was completed by Ibrahim at the State University of New York at Buffalo in 1970. In an effort to test the utilization of CAI in teaching concepts of limits in freshman calculus, Ibrahim used 80 subjects selected randomly from 270 students enrolled in freshman calculus. The subjects were divided into four equal groups. Each group received four hours of lecture and two hours of problem sessions. Subjects in Group A received lecture and problem sessions by CAI, Group B received lecture via CAI and problem sessions with the investigator, Group C received lecture and problem sessions with the investigator; and Group D received lecture and problem sessions with another instructor. All subjects were administered a pretest to measure previous knowledge of the concepts of limits, a posttest to measure achievement, and a post-posttest to measure retained knowledge. Attitude toward mathematics and attitude toward CAI were also measured. Analysis of covariance was utilized to determine between group differences on all variables. In analyzing immediate achievement, the CAI students were found to be significantly better than traditionally taught students; however, there were no group differences on retained achievement. There were no significant differences in either of the attitude measures although most students had a favorable attitude toward CAI (Ibrahim, 1970).

A second study which demonstrated the use of CAI in mathematics education was completed at the University of California, Los Angeles (Arnett, 1976). Undergraduate students enrolled in Essentials of Accounting during the spring quarter, 1975, at California State College served as subjects for this study. Two intact sections were selected to be included in this study and randomly assigned to the levels of the treatment variable, one with 37 students using CAI, and one with 40 students with traditional instruction. Both groups were pretested on the first day of class, and SAT College Entrance Examination scores were obtained for each student. Pretest and SAT scores were used as covariates in the analysis of posttest scores. Further, SAT scores were used to group subjects into ability levels --high, middle, and low. In analyzing the data, no significant differences were evident in either the total group analysis or the analysis by ability grouping (Arnett, 1976).

Balman (1981) reported a system which is utilized at Queen Mary College in London to aid beginning students learn fortran programming. The system is more of a simulation type rather than instructional type CAI in that the programs in the system "act-like" a fortran compiler. The purpose of this system was to design a fortran compiler-like program which did not demand a full fortran program before providing the student with feedback as to the correctness of his code. Six programs were developed which allowed for the incremental compilation of programs, the storage of program files, and program editing. They provide the student with help in (a) assignment statements, (b) format of input and output, (c) translation and modification of programs, and (d) execution of code. The system has been in use since 1978. The author (Balman) believes that the CAIs have aided his students in the early "hands-on" process of learning fortran programming.

CAI Uses in Basic Science

A study designed to evaluate the effectiveness of peer assisted learning and CAI was conducted by Hilbert at Michigan State University in 1977 (Hilbert, 1977). Community College students enrolled in human anatomy, physiology, and medical terminology (N = 108) were placed randomly into a six group Solomon research design. Groups 1 and 2 were pretested and Groups 1 and 3 served as experimental groups receiving both peer assisted learning and CAI in place of the traditional laboratory experience. Group 4 served as the non-pretested control, Group 5 received only peer assisted learning experiences in place of the traditional laboratory experiences and Group 6 received only computer-assisted drill and practice experiences in place of their laboratory experiences. In analyzing the data, the investigator found: (a) there was significantly greater achievement in groups receiving peer assisted learning and CAI, (b) there was no evidence of an influence attributable to the pretest, (c) the experimental groups displayed reduced study time, (d) posttest achievement scores were highest for groups experiencing both experimental protocols, and (e) student attitudes toward the experimental treatments were favorable (Hilbert, 1977).

A study using computer-assisted instruction to simulate physiology laboratory experiences with the cardiac cycle, was conducted by physiologists at the University of Pennsylvania. The study was conducted using four different types of laboratory experiences. One hundred subjects rated the overall quality of each experience. The researchers concluded "It is clear ... that students generally prefer to retain instructor interaction" (Melbin, Riffle & Summerfield, 1980, p. 32). In general, subjects rated the simulation experiences from favorable to very superior in comparison with traditional methods.

At the University of Illinois, 40 programs have been developed utilizing the PLATO IV system (Kane & Sherwood, 1980). One hundred students have been studied with the students utilizing the CAI programs scoring slightly higher than non-PLATO users on posttest achievement measures. These differences were not statistically significant. Programs range in length from 20 minutes to 140 minutes, the latter for a program in two-dimensional kinematics. Of particular interest to physical educators is a program titled Olympic Games Involving Torque which teaches the concepts of torque through the media of sports skills.

CAI Uses in the Health Professions

Perhaps the most prolific use of CAI over the last decade has been in the health professions as evidenced by the number of resources available in these areas (See Appendix B). Indeed, the health sciences included one of the largest number of examples of computer-assisted instruction utilization of any of the academic disciplines. "Presumably, this [use] reflects increasing appreciation of the potential of CBE (computer based education) to enhance medical education and widespread willingness to explore this potential" (Votaw & Farquhar, 1978, p. 54). Again, only samples of the CAI systems being utilized in these disciplines are reviewed.

Pharmacology.

The largest system available in pharmacology is the Computer Aided Teaching System (CATS) developed at the

University of Kansas Medical School Department of Pharmacology. This system is currently in use at 50 medical and pharmacy schools and is also used by a large number of schools of nursing. The CATS contains a series of tutorial CAIs and an item bank which contains 26,000 examination questions. These tutorials are not supplementary to the instructor; rather, the entire course is completed on the computer. Following completion of the modules, the student takes an examination which is administered off-line (Votaw & Farquhar, 1978; Walaszek, 1981).

Medicine.

One of the largest projects of CAI utilization undertaken in medicine is the program in basic medical sciences at the University of Illinois, School of Basic Medical Sciences, Urbana-Champaign (SBMS-UC). The development of this system was supported by a 3-year grant from HEW beginning in 1973. The system was developed for use on the PLATO system centered at the University of Illinois. "The major goal ... was to produce a substantial body of computer based material which would become a functional component ponent in the ... instructional program at SBMC-UC" (Sorlie & Essex, 1979, p. 53). During the 3-year project, approximately 150 PLATO lessons in basic medical science were developed (Sorlie & Essex, 1978). Of these, evaluations were done on 62 lessons related to four particular areas (p. 360). "Based on the ... analyses conducted ... only one analysis (Microbiology of Peptic Ulcer) revealed significant performance differences favoring the user group" (p. 360) on a subsequent examination of achievement. Two of the major accomplishments of this CAI development project were the establishment of a network of medical schools (7) to use and develop lessons and the conversion of the previously mentioned pharmacology system to PLATO (p. 362).

> One of the Project's major accomplishments was that it demonstrated that PLATO IV was a usable and viable instructional system in the basic medical sciences. For example, student users at SBMS-UC felt that Project-authored lessons were good supplements to the basic science curriculum. Students indicated that lessons helped them to learn basic sciences concepts. (p. 362)

Nursing.

As with medicine, the examples of CAI utilization in nursing have increased with rapidity during the last decade. For the sake of brevity, only one study has been chosen for inclusion in this review. This study was selected because of its focus on the effect of CAI instruction in nursing education. Again, further examples may be found in Appendix B.

In a study conducted at the University of California at Los Angeles, the effect of computer-assisted instruction versus lecture-discussion on cognitive learning, transfer of learning, and affective behaviors of nurse practitioner graduate students was tested (Huckaby, Anderson, Holm & Lee, 1979). Thirty-one subjects were divided into two groups; the experimental group (N = 14), and the control group (N = 17). The subject matter presented during the experimental period was clinical management of hypertensive patients. Each of these groups was pretested on knowledge and transfer of learning, the latter being defined as the clinical application of theoretical knowledge of hypertension. The resultant data revealed significantly higher posttest scores on both cognitive learning and transfer of learning which favored the experimental group. Pretest to posttest analysis revealed that both groups improved significantly. The CAI group also scored significantly higher on the posttest measuring the ability to transfer. Huckaby et al. concluded that the findings were consistent with the literature and explained that the factors indigenous to CAI which lead to improved achievement are meeting students' needs, providing opportunities for practice, and giving feedback (p. 231).

CAI Uses in Physical Education

The utilization of the computer in physical education has been quite varied, ranging from a Graduation Plan Analyzer (Gench, 1976), to a program for computing instantaneous velocities from data recorded via stroboscopic techniques (Clark, Paul, & Davis, 1977). Uses tended to be grouped into categories such as data analysis and simulation.

At the State University of New York at Buffalo, "To date, three computer-based resource units (CBRU) dealing with physiology of exercise, sex education and weight control have been completed and evaluated for college health and physical education" (Hill, 1975, p. 26). The CBRU contains objectives, content items, activities, materials, and measuring devices and allows instructors to select their own instructional objectives based on their needs and interests. The CBRU system generates content outlines, suggestions for learning activities, lists of instructional materials, measuring devices, and suggestions for individual activities for each objective requested (Hill, 1975).

One instance in which a computer has been used for the purpose of instruction is a programmed PLATO lesson in physical education curriculum planning (Fry, 1974). The primary purpose of this study was to develop and evaluate a computer-based simulation technique for teaching physical education curriculum planning (p. 5).

> More specifically, the major problem was to develop a PLATO progam which allowed professional students to assume an active role in planning a physical education program which orginated from ... the Purpose-Process Curriculum Framework ... and which resulted in the selection of learning activities appropriate to the conditions imposed by the simulation. (p. 10)
>
> The system is capable of dealing with many of the variables which could be considered in physical education planning such as: theoretical bases of program planning, curricular alternatives, ... community characteristics, facilities, equipment, ... and characteristics of students and faculty. (p. 34)

The program was designed to allow physical education major students to complete curricular choices for grades six, seven, and eight. Subsequent to the development of this 43 frame PLATO program, 5 subjects volunteered to participate in the final evaluative phase of this study. The two research questions to be answered were:

> 1. Does the experience result in the development of a physical education curriculum that is acceptable within the guidelines and limitations of the simulated situation?
>
> 2. What are the similarities and differences among individuals in the decision making process as revealed by the monitoring program? (p. 59)

Data analysis which was relevant to question one indicated that 80% of these subjects (4 out of 5) successfully developed curricula which were within the range of goals for each grade level. This finding referred to the percentage of agreement of activities relating to key concepts as identified in the curriculum model utilized for this study. Data which were analyzed in relation to the second question were the similarities in the time it took the subjects to complete the program and the comparison of activities which were selected by the subjects. There was a trend toward less time for completion for planning grade 8 ($\underline{M}$ = 19.9 minutes) as opposed to grade 6 ($\underline{M}$ = 39.3 minutes). "This finding suggests a learning function possibly due to increased familiarity with the content, the process, or the PLATO terminal" (p. 65). Activities which were common to all 5 subjects were basketball, track and field, and gymnastics. The remaining 29 activities were chosen with varying frequency with only creative movement having been selected by as many as four of the subjects (p. 66). Fry (1974) concluded that:

> Student participation in the program resulted in the development of acceptable physical education curriculum designs ... and the ... program collected sufficient data to allow identification of many similarities and differences among students in the decision-making process. (p. 81)

In the subdiscipline of kinesiology and biomechanics, the primary utilizations of the computer have been in the area of computer simulation of human motion (Miller, 1971) and data analysis (Francis & Boysen, 1978; Plagenhoef, 1971). One physical educator at Iowa State University is utilizing the computer for prerequisite instruction leading to a course in the biomechanics of human movement (Francis & Boysen, 1979). Five PLATO lessons have been developed in the drill and practice mode to teach students the following: (a) to recognize major bones and bony landmarks, (b) the function of different types of joints, and (c) the origins, insertions, and actions of the major muscles of the body. The muscles are classified into those of the upper extremity, those of the lower extremity, and those of the abdomen, thorax, and back. Each classification is addressed in a separate program. The authors produced these programs in an effort to equalize the knowledge base of graduate students entering the aforementioned course in biomechanics. While the authors provided no evidence of the effectiveness of their programs, they indicated that fewer problems were encountered in the entry level of students since these programs were developed. It was in part because of this lack of instructional uses of the computer in kinesiology that the present investigation was planned.

Modes of CAI

The number of classifications utilized in developing CAI instructional material was dependent on the source read. For example, Dwyer (1970) listed seven modes of program presentation: (a) drill and practice, (b) tutorial, (c) simulation, (d) inquiry, (e) gaming, (f) problem solving, and (g) computer-aided laboratory. Dence (1980) listed these same general classifications except that she omitted computer-aided laboratory, including it in simulation, and added the classification of dialog. For the purposes of the present investigation, the modes of content presentation are classified as follows: (a) drill and practice, (b) tutorial, (c) dialog, and (d) simulation.

"The simplest and most used form of CAI is the drill and practice approach that is designed to complement instruction received from teachers, printed materials, and other noncomputer sources" (Sanders, 1977, p. 341). The computer supplies immediate feedback to the student regarding the appropriateness of his responses as he answers questions posed to him by the computer. This approach is used widely in education, notably in those academic disciplines where rote memory is essential; such as, in mathematics, statistics, languages, reading, and spelling (Sanders, 1977).

"This technique allows the student to practice particular skills or knowledges to some level of proficiency or mastery" (Fry, 1974, p. 25).

"A second and more complex level of interaction between a student and a CAI computer program is found in the tutorial approach" (Sanders, 1977, pp. 341-342). Using this method, the computer assists in presenting new material and acts as a private and extremely patient tutor for the student. In both of these approaches, the allowable computer/student interaction is designed with the programmer having nearly complete control of the structure of the interaction, the sequence of learning, and the judgment of appropriate responses.

A third mode for programming CAI material is dialog. This approach provides unstructured interaction between the student and the computer. While advances have been made in the last few years, computer researchers are still investigating the numerous problems inherent in this method and, it is hoped, will have solved them in the not too distant future (Sanders, 1977).

The final mode in which CAI programs may be written is simulation. The simulation mode occurs when the programmer provides an artificial physical, mathematical, or social environment and allows the student to manipulate it by changing certain parameters. Garbutt, Murphy, and Vardy (1979) have developed a simulation in which students manipulate the parameters of size of the breeding population, degree of in-breeding, and maximum population size to study the process of natural selection in genetics. This type of CAI has also been used by kinesiologists (Miller, 1971), physiologists (Melbin et al., 1980), and in education (Judd, 1972) in an effort to provide real experiences for students in these academic disciplines.

Advantages and Disadvantages of CAI

The advantages of computer-assisted instruction, as for any type of instruction, must be determined by the effectiveness of instruction and its cost efficiency. In the studies previously reviewed in this section, computer-assisted instruction was determined to be at least as effective as traditional methods. Edwards, as cited in Kulik and Kulik (1979), examined 20 studies of computer-assisted instruction and traditional lecture discussion which compared student performance as measured by achievement. Edwards identified nine of the studies in which achievement was greater for those subjects participating in computer-based instruction (p. 75). However, there were no significant differences in the remaining studies. According to Simonsen (1974) effectiveness also may be measured by the time required for learning. "In all studies investigating time required for learning ... it took less time for students to learn with computer-based teaching" (Kulik & Kulik, 1979, p. 75). The cost effectiveness of computer-assisted instruction is less amenable to analysis. According to Kearsley (1977), "CAI has a built in success factor: as it becomes more widely used, hardware and software costs go down due to mass production and dispersed costs ... while the costs of traditional instruction continue to increase" (p. 110). The current cost of the PLATO IV system, $2.05 per student hour plus $1000 per hour of instruction for the development of educational materials (Computing Newsletter, 1975), may be prohibitively expensive, but the advent of the personal microcomputer has put computer-assisted instruction hardware well within the range of the budget at most universities (Poirot, 1980).

CHAPTER III

PROCEDURES

The purpose of this investigation was to develop an original series of computer assisted instruction programs focusing on the sub-discipline of kinesiology. The procedures involved two phases: one phase was devoted to the development of the CAI programs, the other to the evaluation of the usability of these programs. A CAI program which introduced the student to the computer system, computer organization, the utilization of the terminal, and data and program instruction input was included because it was expected that the use of these CAI programs would probably be an initial computer contact for these students. The methods and procedures which were followed during the course of the investigation are presented in this chapter under the following headings: (a) preliminary procedures, (b) content analysis, (c) program development, (d) User's Manual, (e) selection of subjects, (f) program implementation, and (g) program testing.

Preliminary Procedures

Prior to the formulation of definite procedures for this study, the investigator completed an exhaustive search of the existing literature in the area of computer assisted instruction. This search included: (a) Dissertation Abstracts, (b) Educational Resources Information Center (ERIC), (c) Psychological Abstracts, (d) The Reader's Guide to Periodical Literature, and (e) The Education Index. The following descriptors were utilized in this process: (a) curriculum development, (b) computer aids, (c) data processing in education, and (d) computer assisted instruction.

Following the completion of the review of related literature, a tentative outline was developed and submitted to the investigator's dissertation committee. Corrections to the original proposal in accordance with the committee's recommendations were made, and permission to conduct the study was obtained from the Human Subjects Review Committee of the Texas Woman's University (See Appendix A). A copy of the corrected proposal and the letter of permission from the Human Subjects Review Committee were filed in the Office of the Provost of the Graduate School of the Texas Woman's University.

Content Analysis

Polit & Hungler (1978) said that "Content analysis is a method for the objective, systematic, and quantitative description of communications and documentary evidence" (p. 379). Content analysis is utilized most by researchers to describe the characteristics of communication (Holsti, 1968, p. 604). "Content analysis may be applied to such materials as diaries, letters, speeches, diaglogues, reports, books, articles, and other linguistic expressions" (Polit & Hungler, 1978, pp. 379-380). One of the ways to describe the characteristics of communication, and the one pertinent to the present investigation, is to describe "what is said" by comparing messages which have been obtained from two or more sources.

In order to maintain objective and systematic analysis of content, the following steps, recommended by Holsti (1968), were followed during the course of the present investigation: (a) determine the unit of analysis, (b) determine the category system, (c) determine the sampling plan, and (d) determine the quantification system. Because of the nature of the investigation, the unit of analysis was the textbooks written on the subject matter pertinent to the CAI; the category system was the topical design of the texts; and the sampling plan was to utilize all available texts for each pertinent topic. The quantification system was a binary index (yes/no) indicating whether or not the topic was included in the materials (Polit & Hungler, 1978, p. 383). The resultant text materials utilized for each CAI program as well as the data accumulated from the actual content analysis are presented in Chapter IV of this dissertation.

Program Development

"Every use of <u>any</u> type of methodology in education is based, explicitly or implicitly, on a model of the learning process" (Rockart & Scott Morton, 1975, p. 5). Although no exhaustive discussion concerning psychological learning theories was intended or deemed necessary for this investigation, it seemed germane to address this topic as it applies to the development of computer assisted instruction programs. Rockart and Scott Morton (1975) indicated that the stages of the learning process and the characteristics of the material to be learned are the two major variables which must be considered in the structuring of CAI programs. They indicated that other identified variables -- (a) the characteristics of the learner, (b) the characteristics of the teacher, and (c) the learning environment -- are less amenable to operational definitions and/or are very likely to change in the process of utilizing computer-assisted instruction programs (pp. 17-18). Following an exhaustive search of the literature for an operational statement of the learning process, Rockart and Scott Morton (1975) were able to generate what they referred to as "A General Learning Model" (p. 20) which is presented in Figure 1.

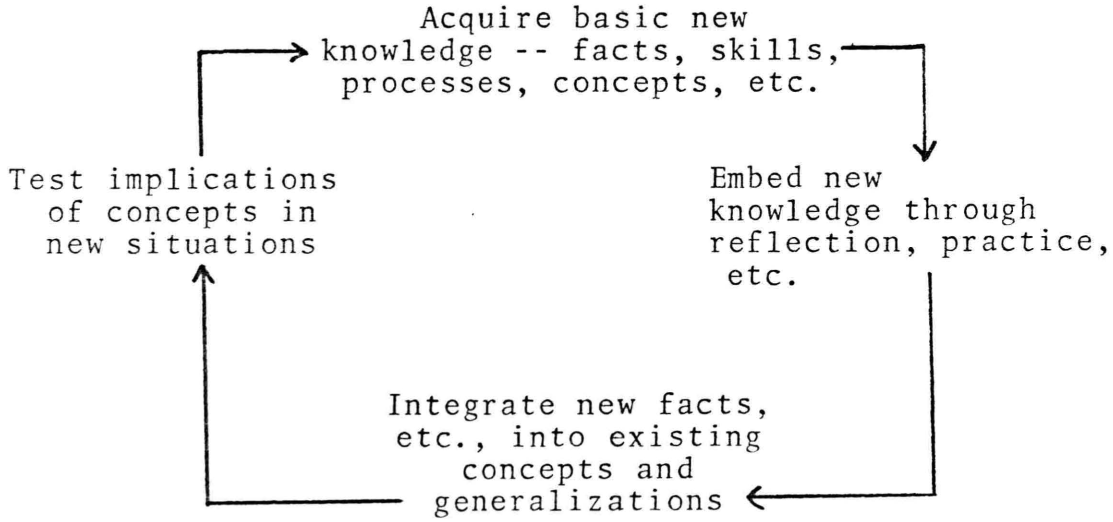

Figure 1. A general learning model.

Rockart and Scott Morton (1975) cited Kolb's theories of experiential learning as the source of their learning model. They (Rockart & Scott Morton) identify learning as a four stage cycle. In Stage I, the learner is exposed to basic skills, data, or concepts; in Stage II the learner practices or studies the skills or concepts; in Stage III the learner is assisted in generalizing or integrating the concepts into a more generalized or global situation; and, in Stage IV the learner is tested on the concepts in a new situation (Rockart & Scott Morton, 1975, pp. 20-21). It is this model of the learning process which was chosen for utilization in this study because "the ... model has gained increasing acceptance as a framework for the design of programs" (Rockart & Scott Morton, 1975, p. 19). Figure 2 is a macro-flow chart of the final design of the programs. Clearly, students may either review certain sections or complete the program from the beginning. In the case of review, students may select the topics in which they are interested. Each topic is identified by a number code. Students also may branch directly to the posttest from the review section if they so wish. A sample of the output from Program 2 may be found in Appendix G. Data entered by the subject are preceded by a '?'.

The criterion for "passing" each CAI was set at 80% correct on the posttest. The investigator believed that because of the nature of CAI instruction, an "above average" pass rate could be anticipated. The parallel forms of the

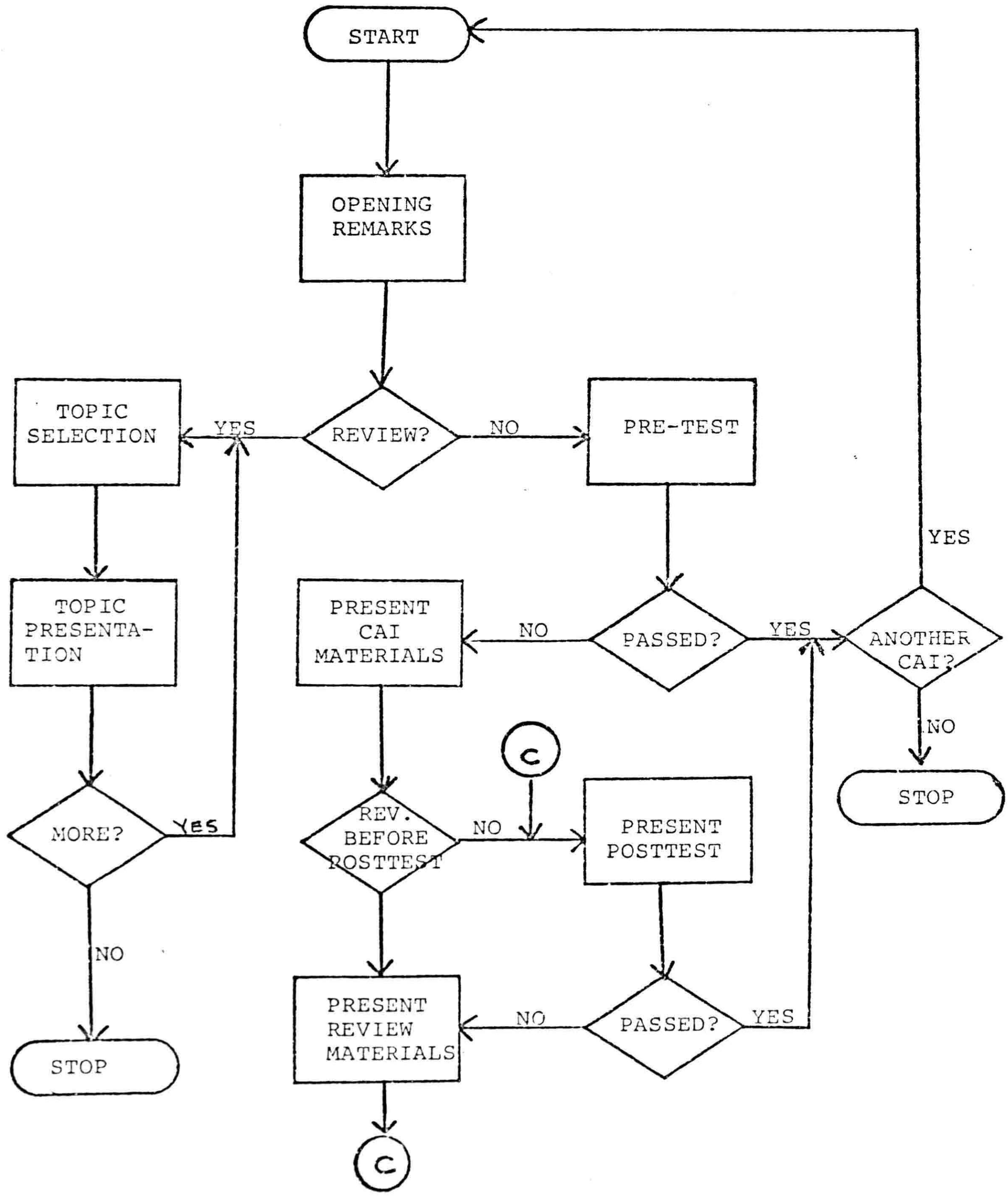

Figure 2. Macro-flow chart for program design.

pretest and posttest materials are discussed in the Program Testing section of this chapter.

User's Manual

As the programs were developed, it became clear to the investigator that a manual for students which would facilitate the use of the system would have to be produced. Included in this manual were instructions for "logging on" and "logging off" the computer. Also included was a section for each CAI. For each program in the series, a set of objectives stated in behavioral terms was developed from the content analysis. The pretest and posttest items were designed from these objectives. The completed manual contains:

1. A description of the purposes for each program.
2. Student objectives for each program.
3. Diagrammatical content which, although necessary to the learning process, was not reproducible on the terminal.

A copy of the manual may be found in Appendix C.

Selection of Subjects

Subjects were selected for this investigation by the following:

1. Subjects were to be students at Texas Woman's University during the first summer session, 1981.

2. Subjects were to be included in the study if they were concurrently enrolled in an undergraduate kinesiology course during the investigative period. Since the programs were designed to be utilized as supplementary material to a course in kinesiology, this was viewed as the target population.

3. Subjects were to be excluded from the study if they had completed high school physics and/or undergraduate kinesiology in college.

Sixteen subjects meeting these criteria were chosen to evaluate the CAI series. The investigation was explained to all of the subjects, and they were asked to sign a consent form indicating their willingness to participate in this investigation (See Appendix D).

Program Implementation

The programs were compiled on a Digital Equipment Company (DEC) System, Model 2050. The DEC-System 2050 is an interactive system which is specifically designed for multiuser capabilities, with input and output to come primarily from either CRT terminals or hard-copy terminals located away from the main computer. The main system contains three Model RP06 disk drives and two Model TU45 magnetic tape drives. The unit of storage is a page, and each page will store 512 thirty-six bit words or 1000 characters.

The programs were written in the BASIC Plus 2 language. This language was chosen because it is utilized extensively for CAI programming and was the best language available for interactive programming on the DEC-system.

The majority of the documentation for the system was written into the programs so that the interaction between the student user and the computer would be more meaningful; however, the User's Manual (See Appendix C) contains programming documentation which was not amenable to inclusion in the programs. Information regarding obtaining the programs may be received from the author.

Program Testing

Although the main thrust of testing the CAI series' effectiveness and usability will occur when the programs are utilized by the students in the target population, some preliminary testing of effectiveness and usability seemed necessary before the presentation of the series as a supplement to classroom instruction. The procedures in this section are presented in the following subsections: (a) program effectiveness, (b) pretest and posttest parallel forms, and (c) program usability.

Program Effectiveness

A pretest and a posttest were written into each CAI program. They were developed from the behavioral objectives for each program and were designed to test the effectiveness of the content material within each program. The pretest to posttest differences for each program were tested utilizing the *t*-test for related groups in an effort to determine whether the content material was reflected in the tests and to determine whether the material was presented in a meaningful fashion. It was expected that these conditions would be revealed through higher posttest scores. All tests were analyzed utilizing a .05 level to determine statistical significance.

Pretest and Posttest Parallel Forms

Following the completed interaction with each program, subjects were asked to repeat the pretest. The scores from the second administration of the pretest and posttest were analyzed utilizing the Spearman Rank Order Correlation technique ($N < 30$) to determine whether the two tests were parallel forms testing the same content.

Program Usability

In order to determine the usability of the programs, a 15 item usability instrument was developed by the investigator (Appendix E). Content validity for the instrument was established prior to its use by a panel of experts. Two of the judges chosen for this panel were experts in the field of computer science because the instrument was to determine computer program usefulness, and the third had extensive experience in producing computer-assisted instruction material. The three judges rated the items on a binary scale as to each item's effectiveness in eliciting the requested evaluation data. The scale contained three subdivisions: (a) to determine the ability of the subjects to use the programs, (b) to determine the effectiveness of the User's Manual, and (c) to determine the attitude toward computer-assisted instruction. Inter-item reliability was determined by examining the percentage of agreement among subjects for each of the three subscales. The results of these analyses are found in the following chapter.

CHAPTER IV

PRESENTATION OF THE FINDINGS

The purpose of this study was to develop and implement a series of computer-assisted instruction programs in kinesiology, a sub-discipline of physical education. The findings of the investigation are presented in four sections: (a) content analysis, (b) subjects, (c) program effectiveness, and (d) program usability. These sections are followed by a discussion of the findings.

Content Analysis

CAI.1

The content for the first program was selected from Sanders' (1977) Computers In Society, and from the investigator's experience both in areas of education and in computer science. This topical list of content was approved by the same panel of judges who determined the content validity of the usability instrument. The final list of topics in CAI.1 is as follows:

1. Input and output devices.
2. Classification of CAI modes of instruction.

3. Functional organization of the computer.

4. Types of computer input.

CAI.2 - CAI.4

Program content related to kinesiology was determined by a topical content analysis of the following textbooks: (a) Hinson (1977); (b) Rasch and Burke (1963); (c) Wells (1966); and (d) Williams and Lisner (1977). Because CAIs have been described as more effective when those faculty members using them were involved in the development of the content, the topics chosen for content analysis were selected from the textbook utilized in the undergraduate kinesiology classes at Texas Woman's University (Hinson, 1977). These original topics were given a weight score of two. The remaining textbooks (Rasch & Burke, 1963; Wells, 1966; and Williams & Lisner, 1977) were searched to determine the presence or absence of the topic and were weighted with a score of one, if present, and zero, if it were not present. For a topic to be included automatically in the final program. a total weight score of four or more was necessary. Table I reflects the topics which were included in each CAI and the total weighted score of each.

Table 1

Total Weighted Scores For Topics

CAI.2

TOPIC	SCORE	TOPIC	SCORE
Reference Positions	4	Static Equilibrium	4
Planes and Axes	4	Levers	4
Center of Mass	4	Leverage Systems	4

CAI.3

TOPIC	SCORE	TOPIC	SCORE
Scalar Quantities	4	Excursion Ratio	2
Vector Quantities	4	Types of Muscular Contractions	4
Force Composition	4	Friction	4
Force Resolution	4	Newton's Laws	4

CAI.4

TOPIC	SCORE	TOPIC	SCORE
Motion		Centripetal Force	4
Linear	4	Centrifugal Force	4
Angular	4	Transfer of Momentum	4
Curvilinear	4	Projection	4
Linear Velocity and Speed	4	Spin	4
Linear Momentum	4	Rebound	4
Angular Velocity	4		
Angular Momentum	4		
Acceleration	4		

The list of topics was presented to the investigator's dissertation chairman for final revision prior to programming. The topic of excursion ratio was retained even though it obtained a score of only two in the content analysis because it was included in the textbook in use at Texas Woman's University and was viewed as an important concept by the instructor of the undergraduate kinesiology course.

Subjects

The subjects for this investigation were students enrolled in kinesiology at Texas Woman's University during the first summer session, 1981. A total of 16 students were enrolled in the course, and all of these had an initial contact with the investigator at which time the study was explained. Eleven students agreed to participate in the study and signed consent forms (Appendix D). All subjects met the criteria as previously outlined. Subjects were allowed credit for two kinematic laboratory sessions as compensation for completing the CAI series of four programs. Nine subjects completed CAI.1 and CAI.2; eight subjects completed all four of the programs. The remaining subjects were unable to complete the series in the prescribed time because of their own time commitments and chose not to participate. Appendix F contains a table of raw scores obtained by each subject.

Program Effectiveness

A preliminary investigation of program effectiveness was conducted in two phases. The first phase was a test of the hypothesis: There is no statistically significant difference in pretest mean scores compared to posttest mean scores on each of the four computer-assisted instruction programs. Through this analysis, the presence of specific content was to be verified. The second phase of the analysis was a determination of whether the pretest and posttest were parallel forms of the same test.

Pretest to Posttest Comparisons

Each program was designed with a pretest and a posttest comprised of ten questions each. It is possible to by-pass both of these tests after initially completing the program. It is also possible to retake the posttest if a passing score of 80% is not accomplished on the first trial. The program indicates to the student the topic(s) he/she needs to repeat and provides the opportunity to do so. Pretest and posttest comparisons were made of the scores turned in by each subject on each of the programs. A *t*-test for related samples was the statistical tool utilized for this section of the data analysis.

Table 2 reflects the pretest to posttest differences on the first program in the series. Nine subjects completed the program. The calculated t-value of 12.59 was significant at the .001 level of significance and favored the posttest.

Table 2

Pretest To Posttest Comparison
CAI.1

Source	N	M	SD	SEm	t
Pretest	9	4.44	1.42	.47	
					12.59*
Posttest	9	9.11	.87	.29	

(t .95 (16) = 2.12)
*t .999 (16) = 4.02

Table 3 reveals a statistically significant difference between pretest and posttest scores on CAI.2. The calculated t-value of 5.49 was significant at the .001 level of significance and favored the posttest.

Table 3

Pretest To Posttest Comparison
CAI.2

Source	N	M	SD	SEm	t
Pretest	9	5.00	1.41	.47	
					5.49*
Posttest	9	8.56	1.26	.42	

(t .95 (16) = 2.12)
*t .999 (16) = 4.02

Table 4 demonstrates the differences in scores between the pretest and posttest on the third program. The calculated t-value of 18.71 reflected a statistically significant ($p < .001$) difference which favored the posttest.

Table 4

Pretest To Posttest Comparison
CAI.3

Source	N	M	SD	SEm	t
Pretest	8	4.38	.99	.35	
					18.71*
Posttest	8	9.38	.69	.25	

(t .95 (14) = 2.145)
*t .999 (14) = 4.14

Table 5 indicates the pretest to posttest difference in scores on CAI.4. Two subjects repeated the posttest after reviewing one or more topics in order to obtain a score of 80%. The posttest scores for the second trial were utilized in this analysis. The calculated t-value of 15.39 was statistically significant ($p < .001$) and revealed higher posttest scores.

Table 5

Pretest To Posttest Comparison
CAI.4

Source	N	M	SD	SEm	t
Pretest	8	2.88	.93	.33	
					15.39*
Posttest	8	9.00	.87	.31	

(t .95 (14) = 2.145)
*t .999 (14) = 4.14

All four of the statistical tests conducted to determine program effectiveness resulted in statistically significant differences in the means of the pretests when compared with the posttest. For each analysis, the posttest means were determined to be significantly higher; thus, the hypothesis was rejected. The subjects obtained significantly better scores on the posttest than they did on the pretest; indeed, all subjects obtained 80% or more correct on each of the posttests.

Parallel Forms

Subjects were asked to repeat the pretest following the completion of each program to determine if the pre and posttests were parallel forms. The data were subjected to analysis utilizing the Spearman Rank Order Correlation to determine the relationship between posttest and pretest scores. Spearman Rank Order Correlation was used rather than Pearson Product Moment because of the small sample size. Table 6 reveals the calculated correlation coefficients for each program.

Table 6

Spearman Rank Order Correlation
Posttest To Repeated PreTest

	CAI			
PRETEST	1	2	3	4
1	.81*			
2		.75*		
3			.91**	
4				.43

* Significant at .05 level
** Significant at .01 level

Siegel's technique for establishing the significance of r_s was utilized for this analysis (1956). Table 6 demonstrates that the calculated correlation values were significant for the first three programs. The value for the fourth program was not significant. Because the relationships between the posttest and the pretest were shown to be significant for programs one through three, the pretest and posttest were inferred to be parallel forms which did clearly test the same content.

Program Usability

Table 7 demonstrates the percentage of agreement of the eight subjects on the five items (2, 3, 4, 7, 11) which tested the effectiveness of the User's Manual. This agreement was found in a positive direction indicating that the subjects, for the most part, found the User's Manual to be clear and helpful.

Table 7

Percentage of Agreement
User's Manual Effectiveness

Item	% Agreement
2	62.5%
3	75.0%
4	62.5%
7	100.0%
11	75.0%

Table 8 represents the percentage of agreement among the subjects on those items which were designed to determine subjects' attitudes toward utilizing the program and the utilization of computer-assisted instruction for the study of kinesiology. The pattern of responses among subjects tended to support the hypothesis that the five items were eliciting similar responses, while the percentages of responses indicated that subjects, in general, thought the use of computer-assisted instruction appropriate and enjoyable. Item 14 asked if the material in each program followed the material presented in class. All subjects responded "no opinion" to this item because they were completing the programs prior to the class presentation of the content for each topic.

Table 8

Percentage of Agreement
in Attitudes Toward CAI

Item	% Agreement
5	75 %
8	75 %
13	87.5%
14	N/A*
15	75 %

*Note. N/A - Item 14 was an inappropriate question under the testing conditions.

Table 9 clearly indicates that the five items designed to elicit responses concerning program usability did so quite accurately. However, in examining the responses it was seen that the subjects stated that the programs were too long; they had difficulty with the system; and they had difficulty using the programs.

Table 9

Percentage of Agreement
Program Usability

Item	% Agreement
1	100%
6	100%
9	100%
10	100%
12	100%

The most representative comment made during the evaluation phase was, "The material is hard and we're not talking about it in class, so that makes it harder."

Discussion of Results

The results of this study clearly support the theory that computer-assisted instruction is a viable and effective supplement to classroom instruction. Further, under the conditions of this investigation, the programs were demonstrated to be an effective stand-alone method of instruction for the topics included in the text. The analysis of the pretest to posttest differences revealed that the posttest scores for each program were significantly higher ($p < .001$) than were the pretest scores. These results may be spuriously high since the subjects were not receiving the content in their classroom instruction; therefore, the pretest scores were probably substantially lower than they may have been had the topics been introduced in the class lecture. The subjects reported that it had taken 1 to 1½ hours to complete each of the programs. The subjects believed this to be too long; however, if the programs are utilized as a supplement to instruction rather than as a stand-alone series, the time to complete each program should be reduced. Other recommendations to reduce the time for program completion are addressed in the final chapter of this study.

The Spearman Rank Order Correlation calculations resulted in coefficients which were of sufficient magnitude to support the hypothesis that the pretest and posttest were parallel forms for each of the programs except program four. In comparing the questions from the pretest and posttest included in program four, there was found to be an increased number of mathematical problems on the posttest. The post-test also contained several questions which were written at the analysis level of the cognitive domain (Bloom, 1956). This may have been the reason for the lower statistical result. These questions should be analyzed carefully on subsequent testing of this program series. The data analysis of the usability of the programs indicated that the computer system and the programs were difficult to use. The subjects, in general, were utilizing the TTY 43 hardcopy terminals which were clearly inferior to the CRT terminals. Also, the subjects were trying to complete the programs during peak "user-time" so that the response rate for the time sharing terminals was relatively slow. This appears to indicate that computer-assisted instruction on a large mainframe computer with timesharing can be less than optimal. The long response time may have also contributed to the length of time that it took for subjects to complete the programs. There are several options to alleviate these concerns which would enhance the usability of this CAI series. These are addressed in the final chapter of this dissertation.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS FOR FUTURE STUDY

Summary

The purpose of this study was to develop and implement a series of computer-assisted instructional programs in kinesiology. The programs were designed, coded, and entered into the DEC-System 2050 computer system at Texas Woman's University. Four programs and a User's Manual were produced for use in this research. These programs encompassed content related to mechanical analysis of motion as taught in undergraduate kinesiology. Subsequent to completion of the programs, they were evaluated by subjects concurrently enrolled in an undergraduate kinesiolgy class. All four programs were demonstrated to be educationally effective through comparison of pretest and posttest scores. Subjects were again administered the corresponding pretest following completion of each program. Data obtained from the second administration of each pretest were correlated with posttest data to determine the relationship of the content of these two tests. The results of statistical analyses demonstrated that the pretest and posttest scores were significantly related in three of the four programs. However, the data did not support the assumption that the fourth program tests were parallel forms.

A usability instrument was developed for the investigation. This instrument measured the usability of the programs, the practicability of the User's Manual, and the subjects' attitudes toward the inclusion of computer-assisted instruction in an undergraduate kinesiology course. The data obtained from this instrument revealed that: (a) the system was usable; (b) the User's Manual was helpful; (c) the programs were too long; and (d) the subjects' attitudes toward computer-assisted instruction were positive.

Conclusion

The findings of this investigation led to the following conclusion: Computer-assisted instruction can aid students in physical education by increasing their knowledge of kinesiology.

Discussion

Through this investigation, two major concerns were identified: (a) the usability of computer-assisted instruction on a large mainframe computer with time-sharing capabilities can be less than optimal, and (b) the programs produced as a part of this investigation were viewed as too long by the subjects. One factor which contributed to the length of time which subjects took to complete the series was that the content in the programs was not being discussed concurrently in class. It is believed that both of these concerns can be alleviated by following the recommendations for future study. Because the attitudes of subjects toward computer-assisted instruction in undergraduate kinesiology were quite positive, further use of the system as a supplement to classroom instruction is indicated clearly.

The results of this study have contributed to the growing body of literature which supports the utilization of computer-assisted instruction to supplement classroom teaching. It appears that a combination of events, the invention of the personal computer (by which children are being exposed to computer technology and computer learning at very early ages), and the financial restraints being experienced in many educational institutions will lead to the greater use of technological advances as alternative methods of instruction.

Recommendations for Future Study

The following recommendations are proposed for future investigation:

1. An evaluation of this program series as a supplement to a one semester course in undergraduate kinesiology utilizing a larger number of subjects.

2. An investigation of the feasibility of converting this program series to a microcomputer system dedicated to CAI instruction.

3. The conversion of each topic in this program series to a series of subprograms within a main routine to allow more flexibility for student utilization.

APPENDIX A

TEXAS WOMAN'S UNIVERSITY

Human Research Committee

Name of Investigator: Barbara J. Lease Center: Denton

Address: 1320 Tulane Date: February 6, 1979

Denton, TX 76201

Dear Ms. Lease

Your study entitled The Development and Implementation of a Computer-Assisted Instruction Series to be Utilized as an Aid to Curriculum Methodology in Physical Ed. has been reviewed by a committee of the Human Research Review Committee and it appears to meet our requirements in regard to protection of the individual's rights.

Please be reminded that both the University and the Department of Health, Education and Welfare regulations require that written consents must be obtained from all human subjects in your studies. These forms must be kept on file by you.

Furthermore, should your project change, another review by the Committee is required, according to DHEW regulations.

Sincerely,

C. K. Rozier

Carolyn K. Rozier

Chairman, Human Research Review Committee

at Denton.

mis

APPENDIX B

COMPUTER-ASSISTED INSTRUCTION
EXAMPLES OF USE IN HIGHER EDUCATION

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APPENDIX C

USER'S MANUAL

USER'S MANUAL

Introduction

This User's Manual was designed for student users of the CAI series in kinesiology as a part of the implementation phase of this learning system. Specifically, this manual is designed for the following:

a. to provide student users with basic information which is necessary for the operation of their terminal and,

b. to provide student users with an explanation of each of the programs in the series.

The manual contains three major sections:

a. Section I - Introduction to the Computer System,

b. Section II - Introduction to each CAI program, and

c. Section III - Leaving the System.

Each major section will subsequently be divided into meaningful subdivisions.

SECTION I: THE COMPUTER SYSTEM

A. The System or 'The Little Man Inside'

It is not necessary for you to know very much about the computer on which you will be working. It is a Digital Equipment Corporation (DEC) computer and carries the identification number of 2050 to differentiate it from other DEC computers. The operating system (the little man inside) is very busy keeping track of everyone using the system because it is a time-sharing system. In other words, while you are using the system, so are a lot of other people. The operating system or 'OS' is the part of the computer that keeps everybody sorted out and provides all the users with the files (more on that later) and space that they need to do their work. While you are using the CAI system in kinesiology, you will be using four files; namely, CAI.1, CAI.2, CAI.3, and CAI.4. These files are actually programs which provide you with tutorial information on the subject of kinesiology.

B. Your Terminal or 'Talking Back'

When you are ready to interact with the computer, you will be seated in front of a machine. This machine may look like a typewriter with a television screen attached, or it may look like just a typewriter. This is the piece of equipment (called a terminal) which you will use to communicate with the computer. If a television screen is attached to the keyboard, you are using a machine called a CRT. CRT stands for cathode ray tube, so called because that is what is on the inside of the machine. When you and the computer 'talk' to each other, your comments and the computer's comments will appear on the screen. Since the screen has room for only about 20 lines of comments, when your interaction uses more space than that, the lines at the top of the screen will disappear. If your terminal has no screen, then all comments will be typed on the paper which is in your terminal. Terminals of either type are part of the computer's hardware. Computer hardware refers to pieces of peripheral equipment which are attached to the mainframe (the brains in a box) of the computer and the mainframe. Interactive use of the computer refers to your being able to communicate with the computer and the computer communicating with you on the same machine.

There are three special keys on your terminal that I want you to locate right away because you will be using them. The first is the control key ((CTR) or (CTRL)). You will use this key both to help you get on the system and perhaps while you are taking the CAI programs if you are using a CRT. The second key is the escape key ((ESC)). You will use this key when you identify yourself to the computer. The final special key is marked (RET). It is the return key. You will use this key everytime you enter data in the computer.

C. Getting Started or 'Here We Go'

The first thing you must do is called logging in. This process involves getting the attention of the operating system and identifying yourself to the system. To do this, you must follow a very specific procedure. In the following steps, the data which you enter into the computer are all in capital letters and are underlined, while the computer's responses to you are between apostrophies.

1. Depress the control key and press the letter C while the control key is still depressed.

   <u>(CTRL) C</u>

2. The computer will respond with:

   'Texas Woman's University TOPS-20 Monitor'

   '@'

3. The '@' is called a system prompt. This means that the system is waiting for you to identify yourself.
4. You enter LOGIN PHED.HINSON.(YOUR NAME) (ESC). Be sure to leave the space after LOGIN.
5. When you push (ESC), the computer will respond with '(password)'.
6. You enter KINES (RET).
7. After you push return, the computer will print some identifying information like the following:

   'Job 21 on TTY 19 15-June-81 08:51:29'

   '@'

   This tells you that you have been assigned job number 21 on terminal number 19, and gives the date and time.
8. The computer will also print the system messages of the day, if there are any. But, the last response from the computer will be '@' , to let you know that it is ready for you to enter the next command.
9. You enter BASIC(RET) ; system returns 'Ready'.
10. When you enter Basic, you will leave the TOPS-20 monitor and your interaction will be with the Basic monitor. The TOPS monitor will not forget that you are on the system, but since you are working in

Basic, that system will monitor your progress.

11. When the system returns 'Ready' , the Basic monitor is waiting for you to tell it what you want to do in basic.

12. You enter OLD (RET) ; the system responds with 'Old File Name ---' then you enter either CAI.1, CAI.2, CAI.3, or CAI.4 and push (RET) You may enter only one of these at a time.

13. The system will again respond with 'Ready' . This means that the computer has the file you have asked for in your work space and is now ready for you to tell it what to do with that file.

14. You enter RUN (RET); after a short wait, the computer will begin to present you with the information that is in whichever file you have requested.

15. When you have completed the program, you enter BYE to log off.

The only thing you must remember as you run the program is to enter your choices from the options presented by the program, and every time after you enter data, you must push return.

D. Getting Started Summary

In the following summary, the computer responses are between apostrophies ' ', and your input is underlined.

1. CTRL C
2. 'Texas Woman's Unversity .... '

   '@'
3. LOGIN PHED.HINSON.(YOUR NAME) ESC '(Password)'; KINES RET
4. 'Job X on TTY Y Date, Time'
5. BASIC RET
6. 'Ready'
7. OLD RET
8. 'Old Filename --' CAI.X RET
9. 'Ready'
10. RUN RET

E. Stopping and Starting the Terminal

Remember that the CRT screen will only hold a certain number of lines. The programs you will be running all have places where the computer will stop displaying new material to give you time to read. If you think that you need to stop the terminal at any time, depress CTRL and press S while the control key is depressed. This will stop the machine. To start again, when you are ready, depress CTRL and press Q while the control key is depressed.

F. Correcting A Mistake

If you make a mistake and know it before you push (RET), you may erase it by depressing (CTRL) and pressing U while the control key is depressed.

SECTION II: THE PROGRAMS

Introduction

There are four parts to this section, one part for each program. Each part will include a list of the topics to be presented in that program, the objectives for the program, and any diagrams which are referred to in the text of the program. You will probably want to have a pencil and some paper available for note taking as you take the CAI, especially if you are using a CRT. PLEASE DO NOT WRITE IN THIS USER'S MANUAL.

A. CAI.1

1. Topics

The topics which are presented in this CAI are:

a. terminals and other hardware.

b. computer assisted instruction.

c. computer organization.

d. computer input.

1) data

2) programs

2. Objectives

The dialog in this program has been developed so that the student will meet the following objectives:

The student will be able to:

a. classify computer hardware into input, output, or both.

b. identify type of terminal he/she is using.

c. identify three types of CAIs.

d. select the type of computer assisted instruction program which is appropriate for various learning situations.

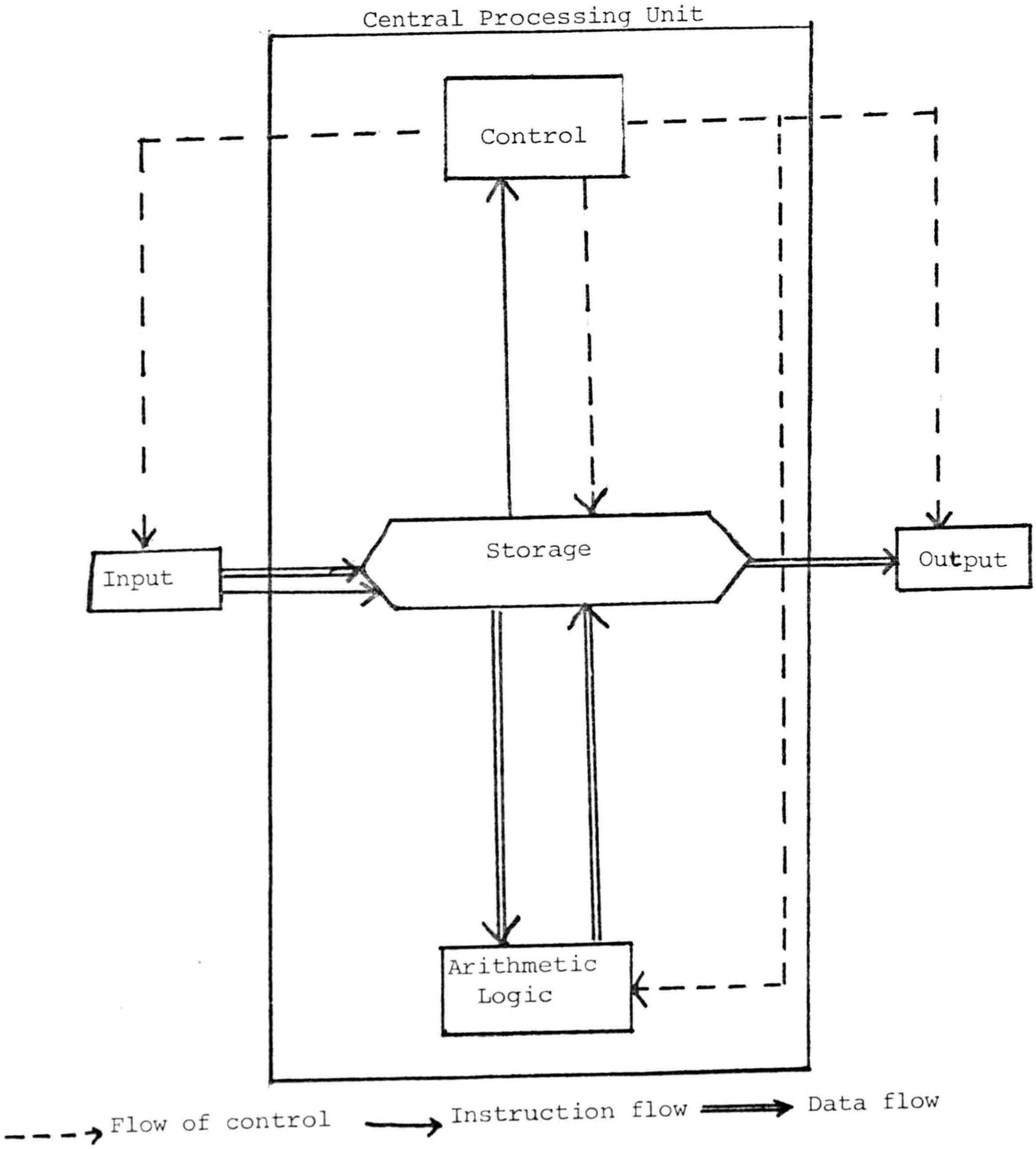
e. select the appropriate unit of the computer based on the function required.

f. differentiate between data and a computer program.

g. name several programming languages.

3. Figures

Figure 1



Saunders, 1977, p.81.

B. CAI.2

1. Topics

The topics which are presented in this program are:

a. reference positions.

b. planes and axes of motion.

c. center of mass and stability.

d. levers and leverage systems.

2. Objectives

The dialogue in this program has been developed so that the following objectives will be met by each student. The student will be able to:

a. identify the reference positions from which motion is analyzed for a given sports skill.

b. select the appropriate reference position to be utilized in the analysis of selected sports skills.

c. recognize the cardinal planes of the body and their associated axes of rotation.

d. classify motion into the appropriate plane and axes of rotation.

e. extrapolate from the principles of stability their application in sports skills.

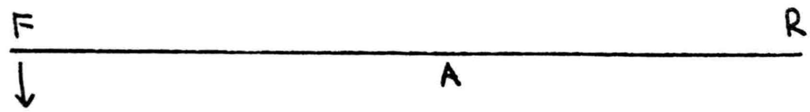
f. identify the classes of levers.

g. compute the forces necessary to balance a lever and the mechanical advantage of levers.

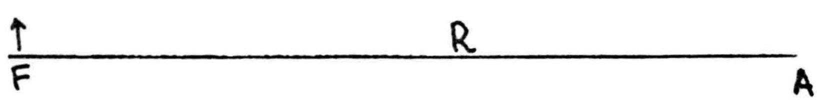
h. recognize how the principles of levers are applicable to motion.

3. Figures

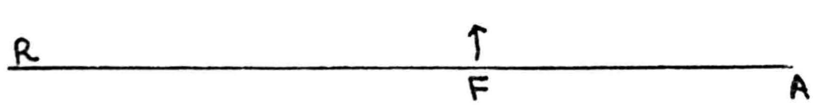
Figure 1



First Class Lever



Second Class Lever



Third Class Lever

Figure 2

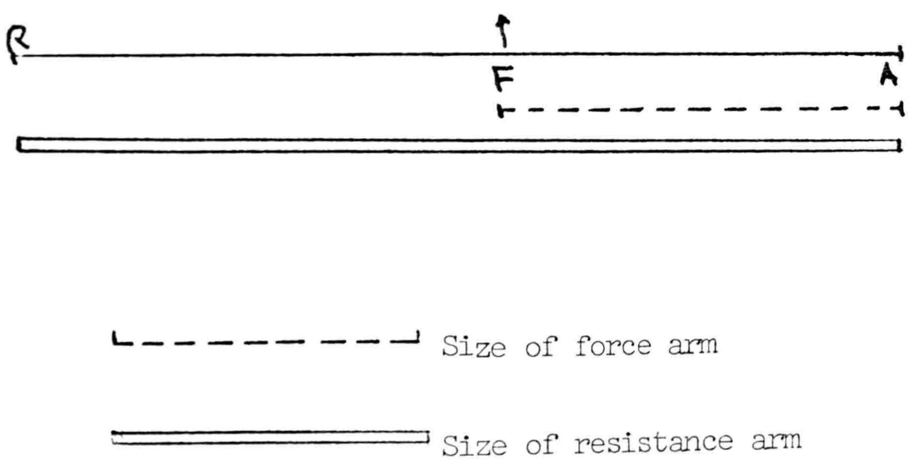
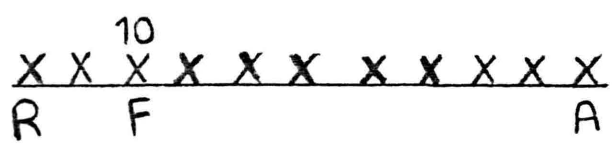
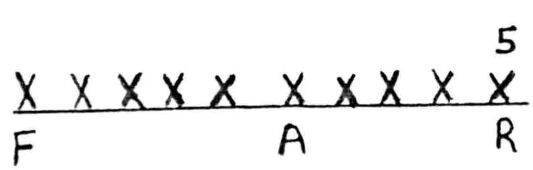


Figure 3





C. CAI.3

1. Topics

The topics which are presented in this CAI are:

a. scalar and vector quantities.

b. composition of force.

c. resolution of force.

d. types of muscular contractions.

e. excursion ratio.

f. friction.

g. Newton's laws.

2. Objectives

The dialog in this program has been developed so that the following objectives will be met by each student. The student will be able to:

a. identify the characteristics of force.

b. distinguish between scalar and vector quantities.

c. determine the resultant of a force graphically.

d. identify three ways in which two or more forces may act together.

e. separate a force into two or more component parts graphically.

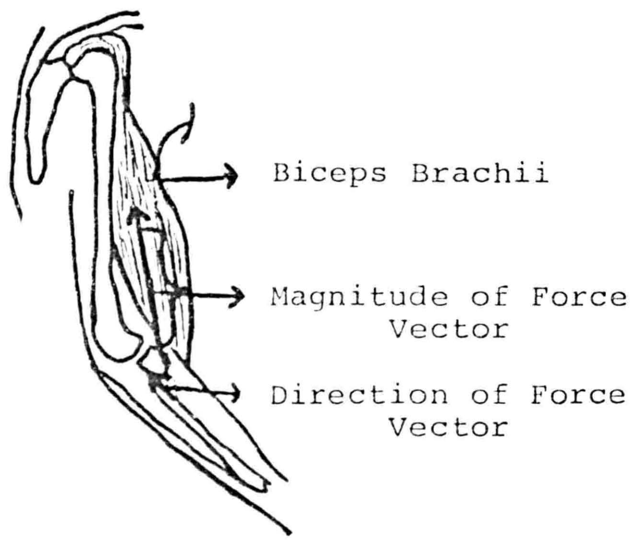
g. list the characteristics of muscle tissue.

h. distinguish between the two types of friction.

i. apply the laws of motion to the analysis of sports skills.

3. Figures

FIGURE 1



Wells and Luttgens, 1976, p. 295

Figure 2A

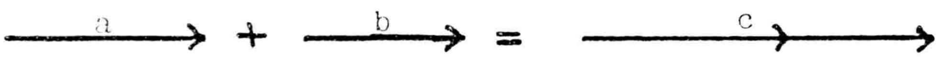
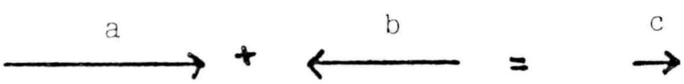


Figure 2B



Wells and Luttgens, 1976, p. 299.

Figure 3A

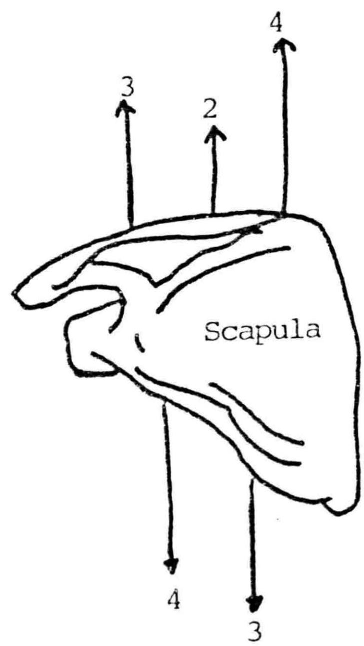
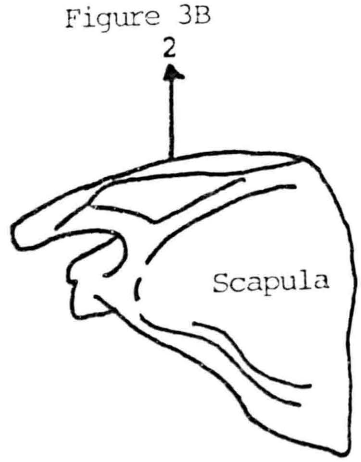


Figure 3B



Hinson, 1981, p. 28.

Figure 4A

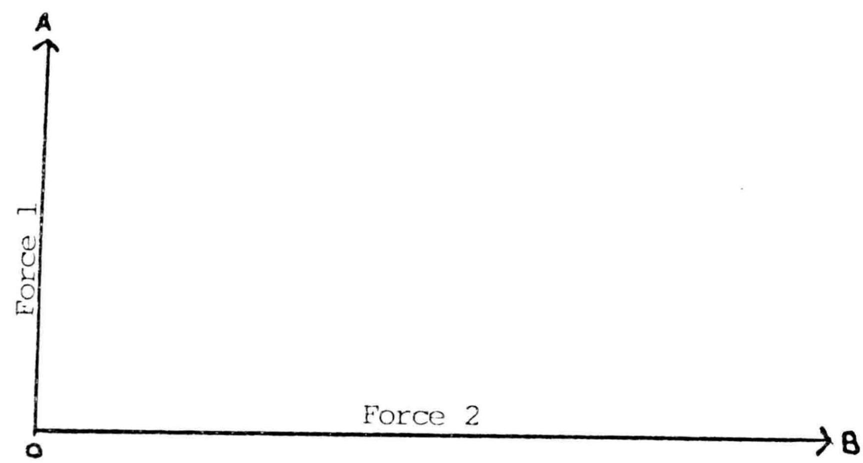
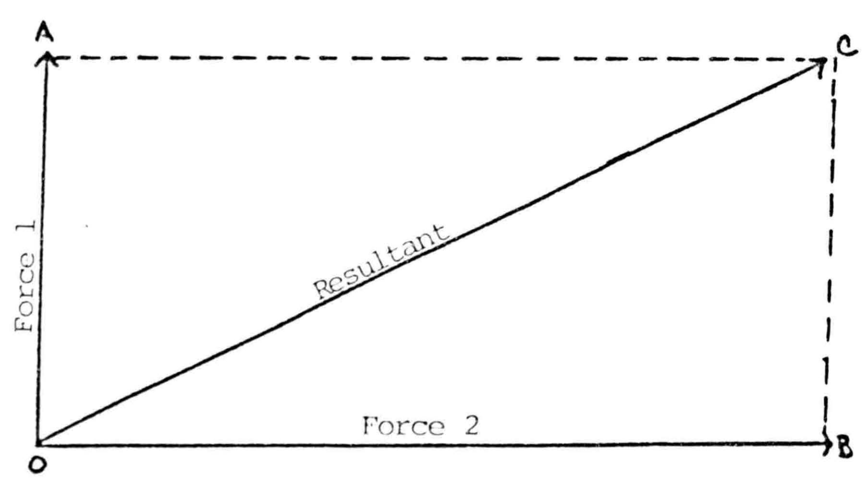
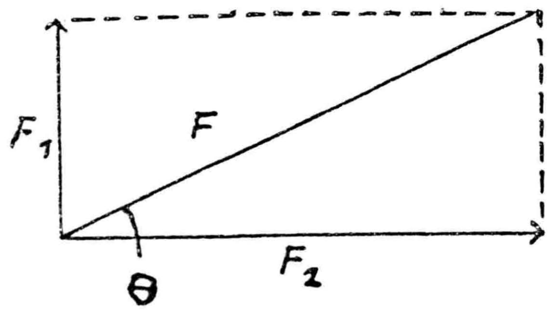


Figure 4B



Rasch and Burke, 1963, p.140.

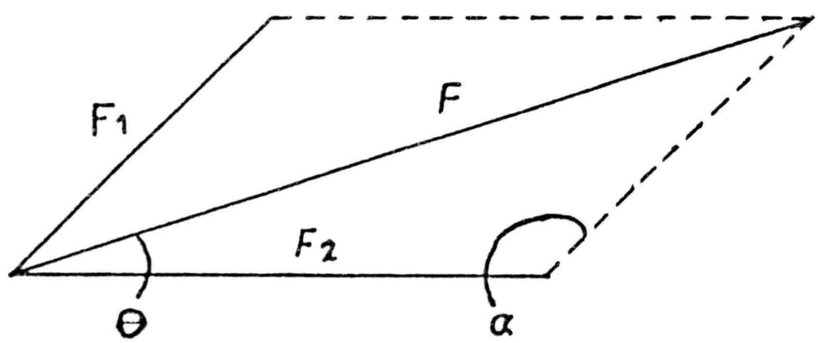
Figure 5



$$F = \sqrt{F_1^2 + F_2^2}$$

$$\sin\Theta = F_1/F$$

Figure 6



$$F = \sqrt{F_1^2 + F_2^2 - 2F_1F_2\cos\alpha}$$

$$\cos\alpha = \frac{F_1^2 + F_2^2 - F^2}{2F_1F_2}$$

$$\text{and } \cos\Theta = \frac{F^2 + F_2^2 - F_1^2}{2FF_2}$$

Hinson, 1981, p.28–29.

Figure 7

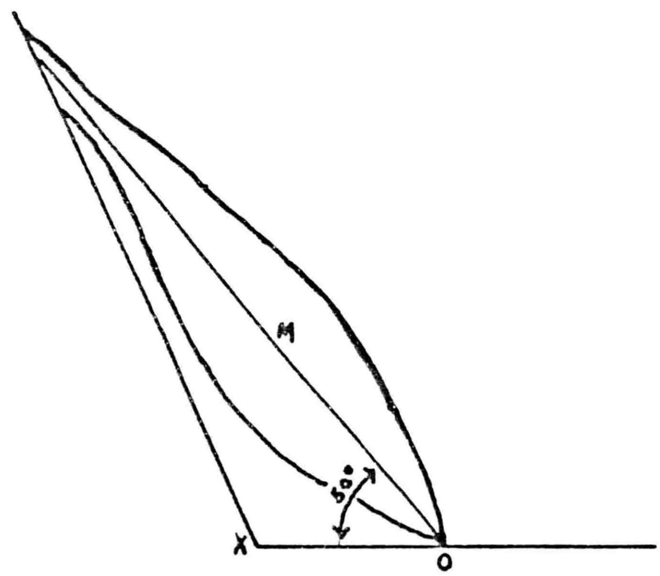
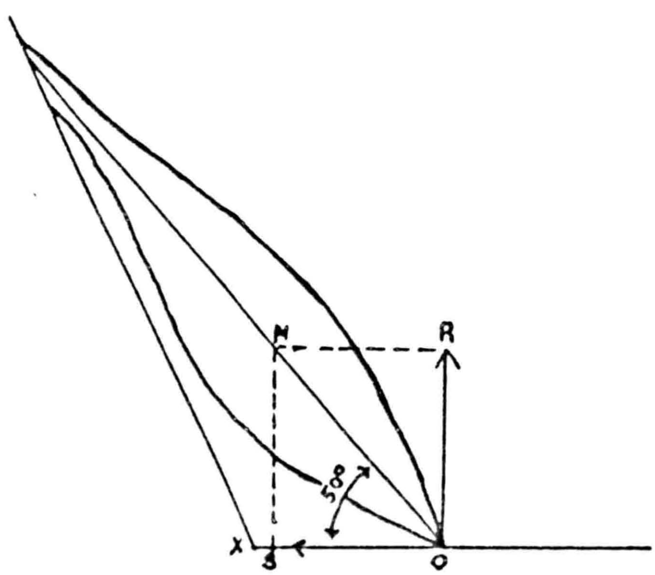


Figure 8

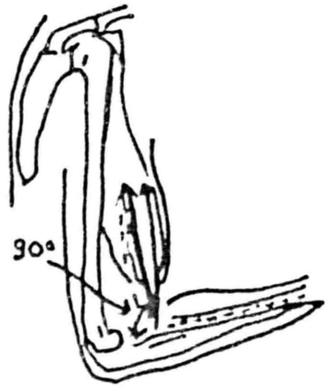


Rasch and Burke, 1963, p.140.

Figure 9

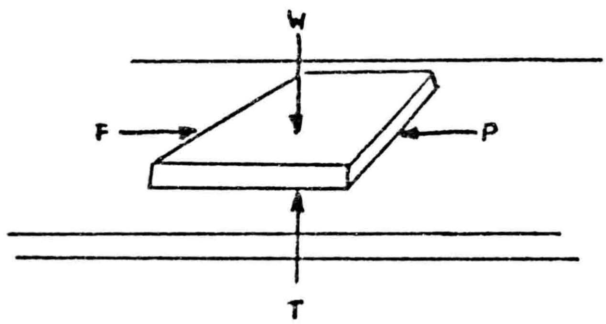
Hinson, 1981, p. 82

Figure 10



Wells and Luttgens, 1976, p.295

Figure 11



W = Force holding surfaces together

P = Force needed to overcome friction

T and F = Equal and opposite forces.

Wells and Luttgens, 1976, p. 343.

D. CAI.4

1. Topics

The topics which are present in this CAI are:

a. motion.

b. centripetal and centrifugal force.

c. transfer of momentum.

d. projection.

e. spin and rebound.

2. Objectives

The dialogue in this program has been developed so that the following objectives will be met by each student. The student will be able to:

a. distinguish between linear and angular motion.

b. contrast the values of speed and velocity, both linear and angular.

c. define momentum.

d. calculate average acceleration and velocity.

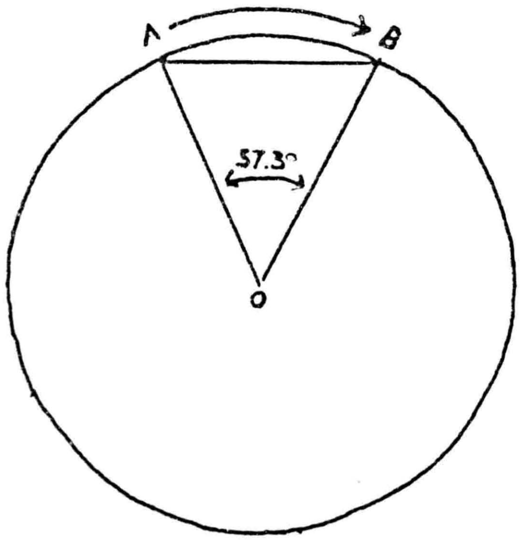
e. apply the laws of motion to the analysis of centripetal and centrifugal force.

f. identify the effect of height of release on the path of a projectile.

g. apply the principles of type of spin to determine the resultant rebound of a tennis ball.

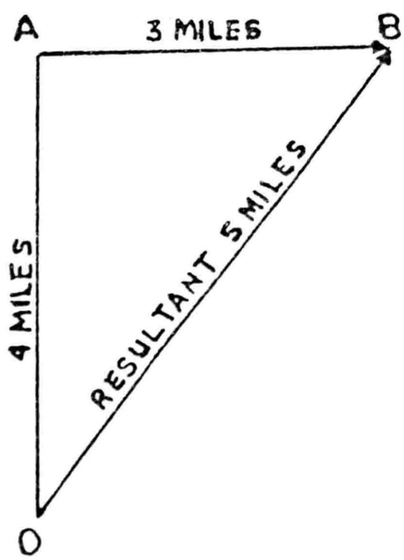
3. Figures

Figure 1



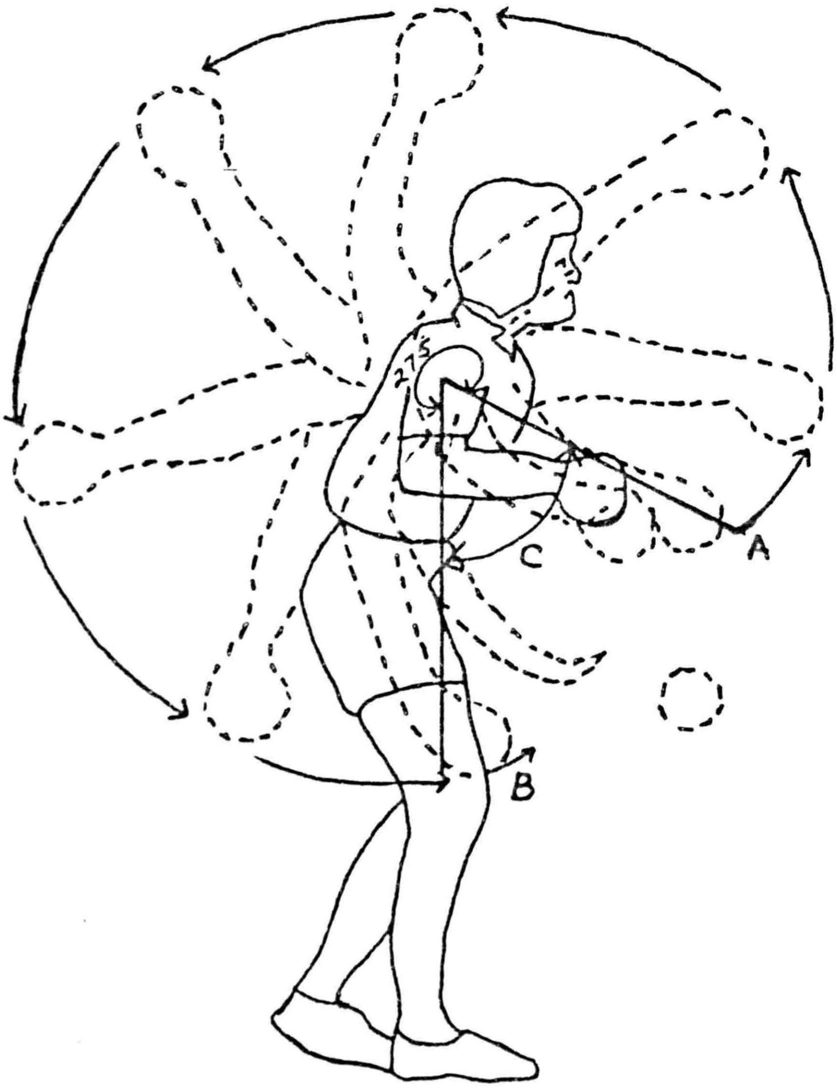
Rasch and Burke, 1963, p. 142.

Figure 2



Rasch and Burke, 1963, p.137.

Figure 3



Hinson, 1981, p.281.

Figure 4A

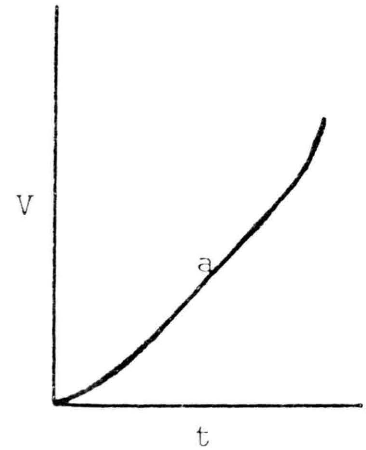
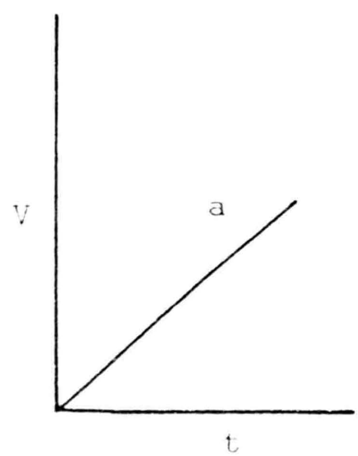


Figure 4B



Wells and Luttgens, 1976, p.276.

Figure 5A

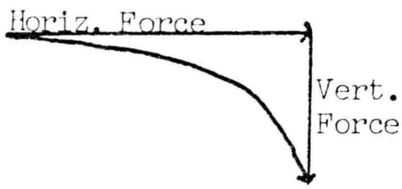
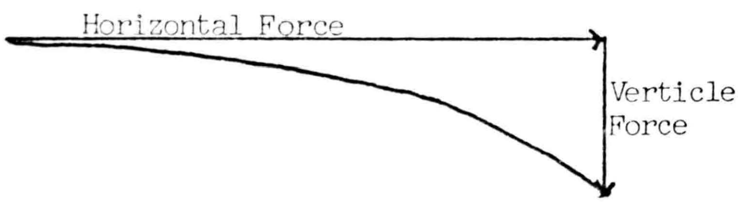


Figure 5B



Wells and Luttgens, 1976, p. 280.

Figure 6A

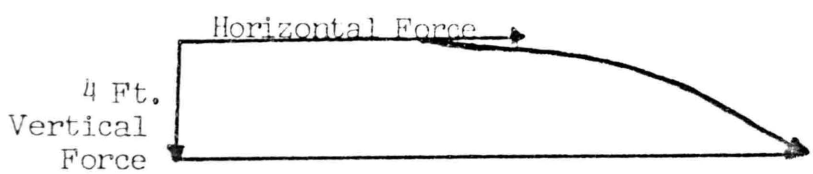
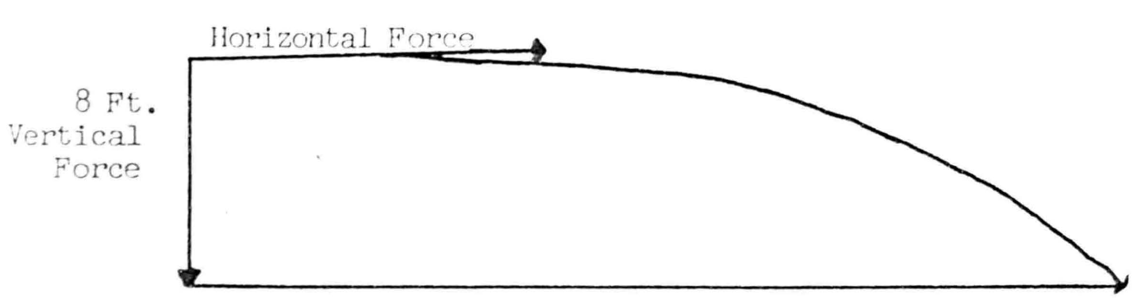
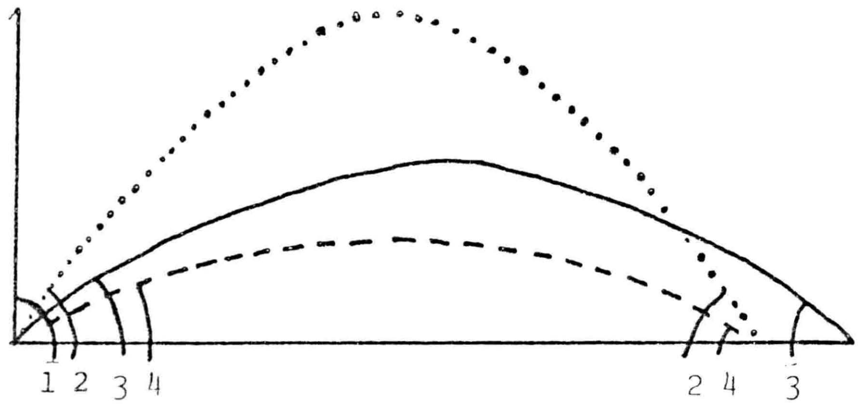


Figure 6B



Wells and Luttgens, 1976, p.280.

Figure 7

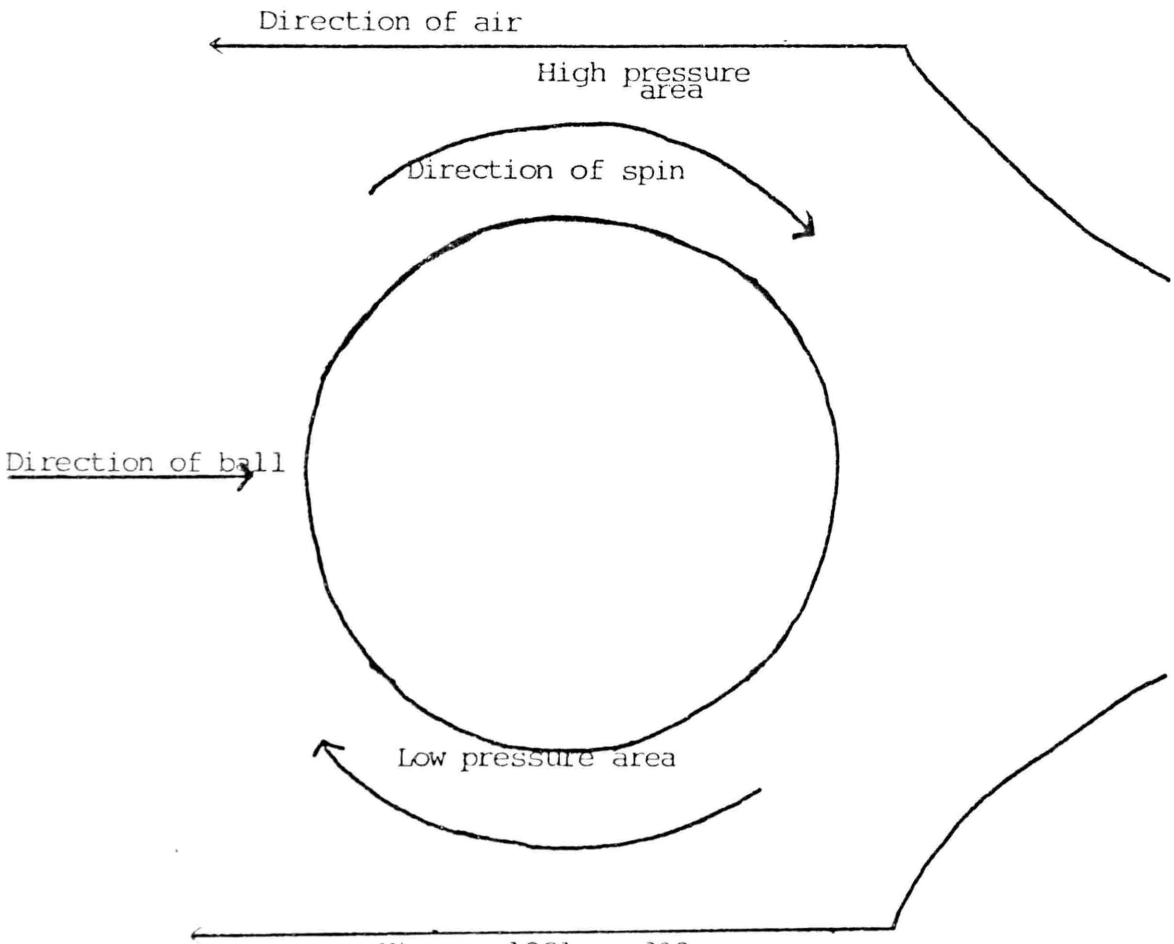


Angles of Projection

1=90 degrees
2=60 degrees
3=45 degrees
4=30 degrees

Hinson, 1981, p. 301.

Figure 8



Hinson, 1981, p.308.

Figure 9A

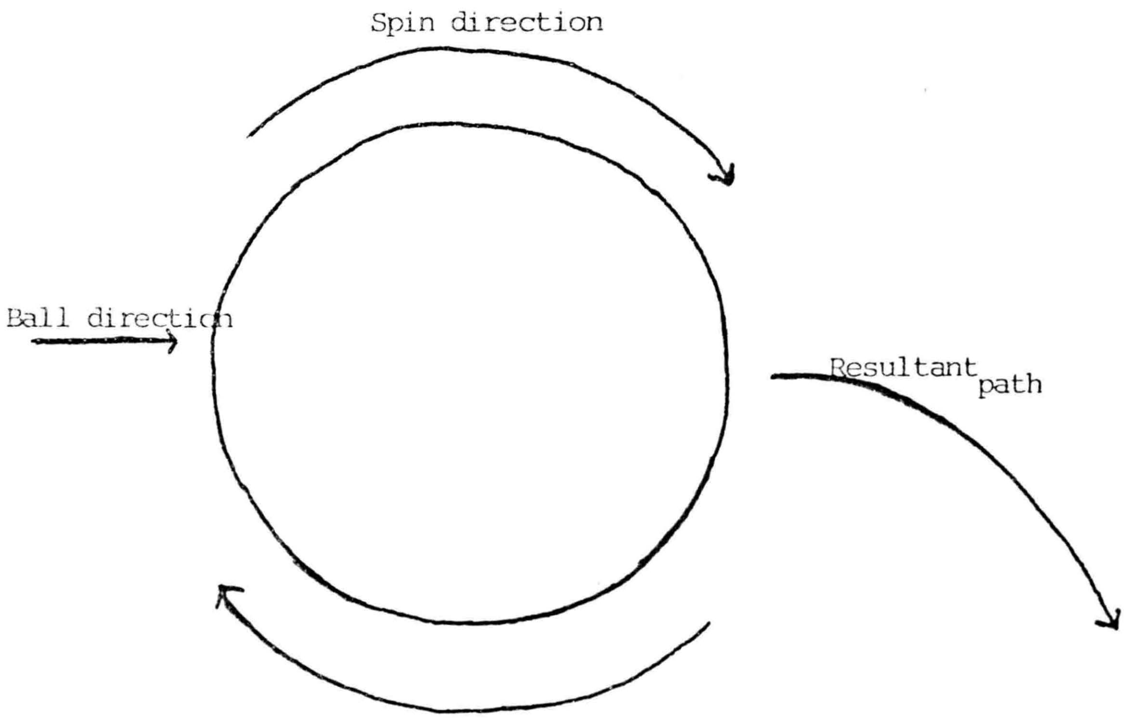
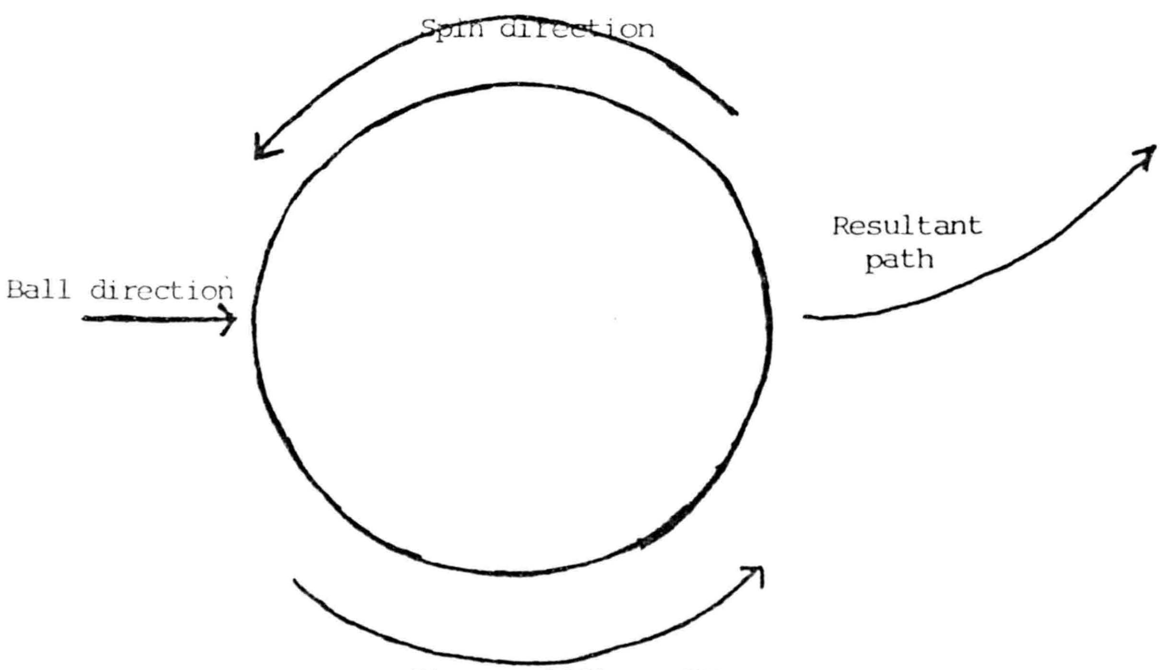


Figure 9B



Hinson, 1981, p.309.

Figure 10A

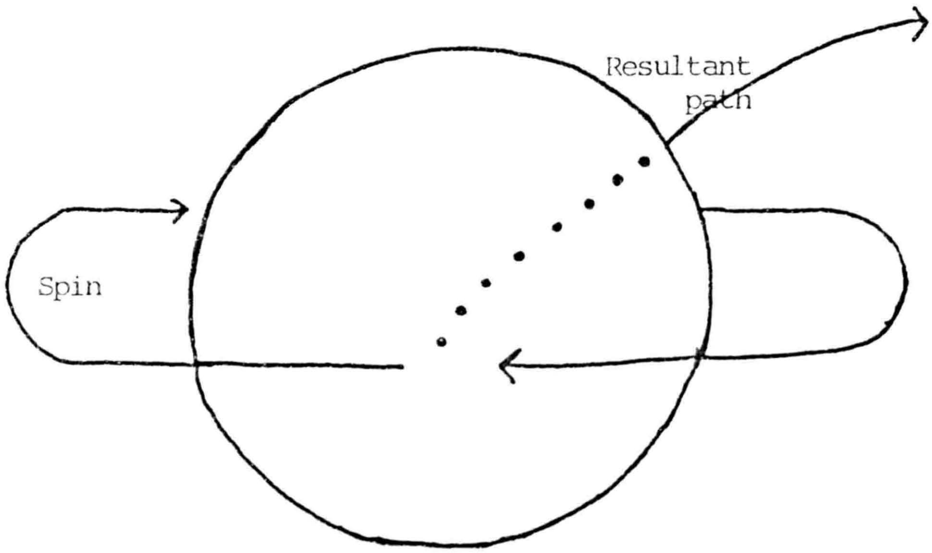
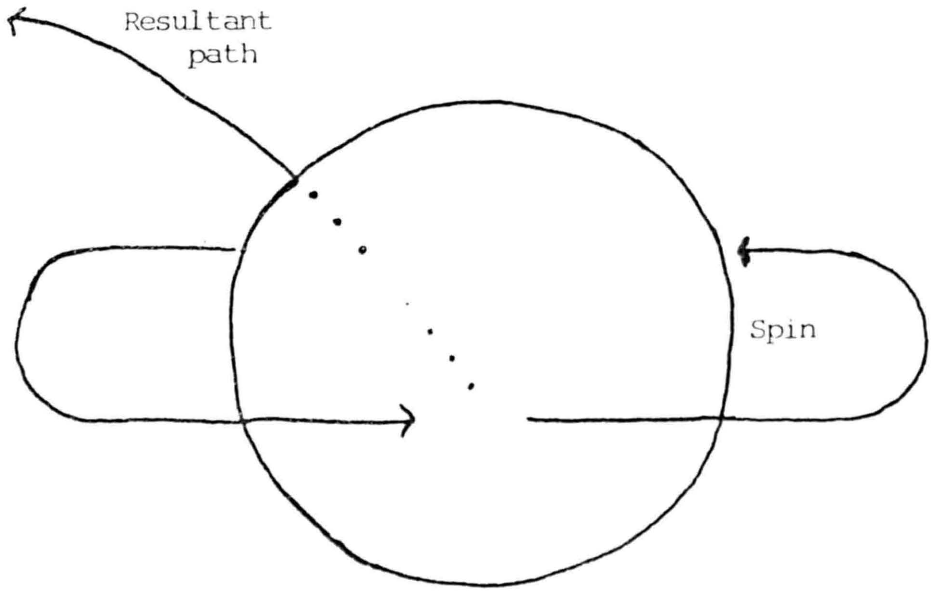


Figure 10B



Hinson, 1981, p.310.

SECTION III: LEAVING THE SYSTEM

When you have completed the final CAI that you wish at a particular sitting (you may not wish to do all CAIs at once), the system will give you the 'Ready' message. You enter BYE. In a few seconds the system will give you a message similar to: 'Killed Job 19 on TTY 25 .... You will then be logged off the computer.

APPENDIX D

Consent Form
TEXAS WOMAN'S UNIVERSITY
HUMAN RESEARCH REVIEW COMMITTEE

(Form B)

Title of Project: The Development and Implementation of a Computer-Assisted Instruction Series to be Utilized as an Aid to Curriculum Methodology in Physical Education

Consent to Act as a Subject for Research and Investigation:

I have received an oral description of this study, including a fair explanation of the procedures and their purpose, any associated discomforts or risks, and a description of the possible benefits. An offer has been made to me to answer all questions about the study. I understand that my name will not be used in any release of the data and that I am free to withdraw at any time.

____________________ __________
Signature Date

____________________ __________
Witness Date

Certification by Person Explaining the Study:

This is to certify that I have fully informed and explained to the above named person a description of the listed elements of informed consent.

____________________ __________
Signature Date

____
Position

____________________ __________
Witness Date

APPENDIX E

USABILITY INSTRUMENT

Please mark each item below according to the following scale: SD = strongly disagree, D = disagree, N = no opinion, A = agree, SA = strongly agree.

1. I found the programs to be easily used.
2. I found the user's manual to be very helpful.
3. I found the stops in the programs to be located appropriately.
4. I found the diagrams in the user's manual to be very helpful.
5. I enjoyed the experience of interacting with the computer.
6. I experienced a lot of difficulty when trying to run the programs.
7. I found the instructions in the user's manual to be very confusing.
8. I felt overwhelmed by the terminal.
9. I found the design (pre-test, presentation of material, questions, help section, review sections, and post-test) of the progams helpful.
10. I felt the use of CAI was appropriate for this material.

11. I found the presentation of objectives for each program to be a helpful preparation to running the CAI.
12. I felt the programs were too long.
13. I feel the use of CAI can be helpful for reviewing before examinations.
14. I found the material presented in each CAI to follow the material presented in class instruction.
15. I would enjoy having more computer-assisted instruction in my university experience.

APPENDIX F

Table 10
Table of Raw Scores
CAIs

	CAI.1			CAI.2			CAI.3			CAI.4		
S	PRE	POST	P-P*	PRE	POST	P-P*	PRE	POST	P-P*	PRE	POST	P-P*
1)	4	8	8	6	6	6	6	10	9	2	8	8
2)	2	8	7	6	10	9	3	9	8	2	10	9
3)	5	10	9	5	8	8	3	9	8	2	9	9
4)	5	10	9	4	8	9	4	8	8	4	8	10
5)	4	9	9	6	10	9	4	9	8	3	9	9
6)	3	8	8	7	8	8	5	10	9	2	8	7
7)	7	10	9	4	9	8	5	10	9	4	10	9
8)	6	9	9	5	10	9	5	10	10	4	10	9
9)	4	10	10	2	8	9						

*P-P = The second pretest score.

Table 11
Table of Raw Scores
Usability Instrument

Item	SA	A	NA	D	SD
1	0	0	0	7	1
2	4	1	3	0	0
3	5	1	1	1	0
4	3	2	0	2	1
5	4	2	2	0	0
*6	2	6	0	0	0
*7	6	2	0	0	0
*8	0	1	0	1	6
9	7	1	0	0	0
10	8	0	0	0	0
11	4	2	2	0	0
*12	7	1	0	0	0
13	7	0	0	1	0
14	0	0	8	0	0
15	5	1	0	1	1

* = Negative items

APPENDIX G

The principle which applies in both receiving and applying force is to widen the base of support in the direction of the force. In receiving an oncoming force, it will help to maintain stability if you lean slightly into the direction of the force.

Well, Barb, let's see if you can apply what we've been discussing in the past few minutes.

```
XXXXXXXXXXX
    A C    B
```

In the above diagram, the X's represent a log. The C is the location of the center of the log, and the A and B represent two people who are carrying the log. The question is, which person is carrying the most weight? Enter A for person A, B for person B, C if the weight is equally distributed between them and D if you don't know.

? D

I'm sorry Barb, let me try to explain.

The correct answer is "a" because person A is nearer to the center of the log. Remember, the closer to the center of

Figure 3. An example of dialog extracted from CAI.2.

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