

**The Effects of Multimedia Computer Assisted Instruction (CAI) on Teaching
Tennis in Physical Education Teacher Education**

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(ABSTRACT)

The purpose of this investigation was to determine the effects of multimedia CAI on undergraduate PETE majors' teaching of the serve in tennis. The data were obtained from 18 undergraduate students enrolled in a PETE evaluation and assessment course at Virginia Tech. Subjects were stratified by gender and randomly assigned to three groups as Computer-Assisted Instruction (CAI) group (n=6), Teacher Instruction (TI) group (n=6), and Control (CG) group (n=6). The results of this study were gathered from three tests: Tennis Serve Content Knowledge Test, Tennis Serve Skill Analysis Test, Tennis Task Sequence Test. In addition, two six minutes micro teaching sessions were conducted and data was collected via Tennis Serve Pedagogical Content Knowledge (PCK) Assessment Sheet, and finally, an open ended survey was completed to understand students' attitudes toward CAI. There are two independent variables in this study. These are Computer-Assisted Instruction (CAI) and Teacher Instruction (TI). A pre-test and post-test experimental design was applied. The Kruskal-Wallis test was used to determine the differences among the three groups, and pairwise ranking with the Mann Whitney U test was conducted between all comparisons as a post hoc analysis. Moreover, the Wilcoxon Signed Rank test was used to determine pre-to post-test changes within the groups. Alpha set at $p < 0.5$. Overall, teacher instruction (TI) intervention was very dominant in the results. Teacher instruction (TI) group performed significantly in the tennis serve content knowledge test, tennis serve task analysis test, PCK-Appropriate cues, and PCK-Appropriate demonstration. However, CAI group was also successful in the tennis serve content knowledge test and PCK-Appropriate demonstration. Interestingly, none of the groups were successful in the tennis serve skill analysis test and PCK-Appropriate feedback. Finally, students' perception toward CAI was positive in general and students indicated that they would like to use CAI in other PETE method courses. However, some of the students reported that CAI was very repetitive, and also technical problems were reported. The results of this study indicated that CAI can be an effective way of instruction in certain conditions: CAI had significant effect on content knowledge and PCK-Appropriate demonstration.

DEDICATION

Dedicated to my parents, Osman and Sevim Konukman. Without their love and support I could not make my dreams today

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CHAPTER 1

INTRODUCTION

Technology in the information revolution has provided many unique benefits to instructional programs. Although traditional ways of instruction are widely accepted in teaching and learning environments, some educational institutions have started to implement computer technology as an instructional approach (Bull et al., 1989, 1991; Harris & Anderson 1991; McKethan et al., 2001; Wagonner, 1992; Wilkinson et al., 1999).

The introduction of computers into the business world in the mid 1950s made important changes for future perspectives because the purpose of the first generation computers had been purely scientific. The early 1960s saw the integration of computers into both business and scientific life, but this was only in limited functions. Microprocessors were used to build microcomputers in the mid 1970s and the first personal computers (PCs) were introduced for individual use in business and in education. An abundance of educational and business software was also developed. In this era, the computer caught the imagination of educators to see how it could enhance learning and thinking.

The evolution of computer-assisted instruction (CAI) shows that CAI has existed for more than 50 years. The first CAI, a flight simulator for pilots, was designed at the Massachusetts Institute of Technology (MIT) in 1950 (Lockard, Abrams, & Many, 1997). One of the first applications of CAI for educational purposes, known as PLATO (Programmed Logic for Automatic Teaching), was developed in the 1960s at the University of Illinois (Hammond, 1972). This program was designed to teach a variety of subjects such as nursing, geometry, and pharmacology.

In the 1970s important developments occurred in CAI. The National Science Foundation provided \$10 million funding for PLATO and TICCIT (Time-Shared Interactive Computer-Controlled Information Television System). TICCIT was developed by Brigham Young University and MITHE Corporation. The main aim of this project was to develop a better teaching and learning environment via computers and television in community college courses such as mathematics and English (Merril et al., 1980). Interestingly, the results of research

conducted by the Educational Testing Service showed that PLATO provided significant gains in chemistry, biology, and English, and TICCIT also provided significant results among community college students in English and mathematics. Moreover, both PLATO and TICCIT students had positive attitudes toward CAI (Steinberg, 1991). In the 1990s, due to lower costs, faster processing power and better multifunctional performance capacity, microcomputers became an essential part of K-12 education, colleges, business, and homes. Microcomputers have a better capacity to perform multifunctional roles such as computer-assisted instruction, word processing, and spreadsheet processing.

Definition of CAI

Computer Assisted Instruction (CAI) has been used for more than five decades for educational purposes. Although the use of computers is not new, CAI is still a popular and common terminology in today's educational institutions and schooling process. CAI provides an instructional interaction between the learner and the computer in a variety of contents with or without the assistance of a teacher. (Lockard, Abrams, & Many, 1997). In this process, CAI helps the learner(s) by presenting material and acting as a tutor. CAI uses the computer to facilitate and improve student learning. Students interact with computers at their own pace and the role of the teacher becomes a facilitator or coach. CAI programs direct the learner's attention to different sections in a learning sequence without the direct assistance of a teacher (Petrakis, 2000).

Although a wide variety of microcomputers and CAI software are available in the market, the ideas driving the instructional tasks in CAI programs are not new. Some of the features of CAI have originated from the learning theories of B.F. Skinner and E. L. Thorndike. The effect of these psychologists' research on stimulus-response relationship, negative and positive reinforcement, and the role of immediate feedback in a teaching and learning environment has promoted the development of programmed instruction (Volker, 1987). Programmed instruction helps the teachers to organize lessons in a linear or branching model that allows sequential steps and provides immediate feedback during the learning process. This type of programmed instruction is followed exactly in the majority of CAI programs.

Recently, information technology has been integrated into teacher education courses in many ways, such as CD-ROMs, interactive videodiscs, teleconferencing, electronic mail, and microcomputers with hypermedia/multimedia programs. Computer assisted instruction is just one of these technological applications.

Research in CAI

Although CAI has been used for more than 50 years, there is limited research on the effectiveness of CAI. In fact, several research studies have found no effects of CAI on certain subject matters. Overall, research on the effectiveness of CAI has produced inconsistent results.

In considering the use of CAI as an intervention or instructional material some research studies have indicated that the use of CAI improved student achievement for the following: mathematics and reading of low achieving students in 5th grade (Weller et al., 1998); verbal and language skills of preschoolers (Shute & Miksad, 1997); early academic skills of preschool students with disabilities (Hitchcock & Noonan, 2000); development of first grade learning skills (Erdner et al., 1998); and cognitive and psychomotor skills in a collegiate basic instruction tennis course (Konukman et al., 2001).

In contrast, another group of studies has found no effects of CAI on the following: writing skills in a business communication course (Wedell & Allerheilingen, 1991); a fundamentals of mathematics course (Ford & Klicka, 1998); critical thinking skills of nursing students (Saucier et al., 2001); and the multiplication skills of elementary students with learning disabilities (Wilson et al., 1996).

CAI in Physical Education

Recently, many physical education teachers are becoming familiar with the use of microcomputers in K-12 physical education classes. Computer applications are used by physical education teachers in data management for record keeping, planning and communication (Lambdin, 1997). Computers have been used to help 10th grade students to analyze their tennis strokes using biomechanical principles via Measurement in Motion software (1994). In addition, students receive information about health-related fitness by interacting with the MacHealth-Related Fitness/Portfolio (Mohnsen, 1997). However, there is limited research evidence about

the effectiveness of CAI on K-12 physical education classes. Research in K-12 physical education shows that CAI has produced positive results in female junior high school students' psychomotor volleyball skills (Wilkinson et al., 1999) and 12-year old students' badminton knowledge (Skinsley & Brodie, 1990), and had no significant effect on teaching tennis rules, scoring, and terminology to fifth grade students (Alvarez-Ponns, 1992).

Research completed in basic instruction programs at the college level does not support the effects of CAI on bowling knowledge (Steffen & Hansen, 1987) and tennis knowledge and rules (Kerns, 1989). Only one study has found results that support CAI on cognitive and psychomotor skills in tennis (Konukman, et al., 2001).

The majority of the research on CAI has been conducted in PETE and athletic training programs. Research in PETE programs has been in the field of biomechanics, kinesiology, and athletic training courses. Some of these studies have found that CAI has a positive effect on undergraduate athletic training courses (Buxton et al., 1995; Chen et al., 1995). In addition, two research studies found no significant effect of CAI on undergraduate physical education majors' knowledge in biomechanics courses (Boysen & Francis, 1982; McPerson & Guthrie, 1991).

On the contrary, research on the effects of CAI in physical education method courses is limited and until now there have only been two studies that produced results that do not support CAI as an effective instructional method. McKethan et al., (2000) conducted a study to determine the effects of a multimedia computer program on preservice elementary education classroom teachers' knowledge of cognitive components of movement skills such as overhand throw, catch, and kick. Researchers used critical components of the cues to assess subjects' knowledge. Results indicated that there were no significant differences on specific cue descriptions. In another study, McKethan et al., (2001) replicated the same study on physical education majors' knowledge of cognitive components of movement skills. However, the study found no significant effects of CAI. Consequently, similar to other subject matters, research in K-12 physical education and PETE has produced different and inconsistent results related to CAI as an instructional strategy.

A General Overview of CAI Programs

Today, a wide variety of CAI software is available in different subject matters from preschool to adult learning. It is very interesting that despite the common usage of CAI, there is still an ongoing discussion in the literature and learning environments about the effectiveness of CAI.

Several studies have recognized the following advantages of CAI (Kulik et al., 1980; Lockard, Abrams & Many 1997; Petrakis, 2000; Steffen, 1985).

1. Performance feedback is immediate and based on the number of correct or incorrect responses.
2. Lessons are individualized.
3. The environment is paced and controlled by the learner.
4. The learner has the opportunity to backtrack for review.
5. The CAI program maintains performance records for assessment and evaluation.
6. The computer provides a useful environment for simulations.
7. CAI is time effective for instructional use in the classroom.

The graphics, sounds, and color offered by CAI offer a user-friendly environment. On the other hand, these studies also reported the following disadvantages of CAI.

1. Students using CAI are isolated from peers and the school environment.
2. CAI learning is individualized rather than cooperative.
3. The instruction is offered in a dehumanization manner.
4. Teachers take on passive roles, and become facilitators rather than instructors.
5. Technical malfunctions can distract students easily.

From the above lists, one can see that the advantages of CAI outweigh the disadvantages. Therefore these studies show that CAI is a feasible option for learning.

Statement of Purpose

The purpose of this study is to determine the effects of multimedia CAI on undergraduate PETE majors' teaching of the serve in tennis.

Research Questions

The following questions will be used to determine the relative effectiveness of multimedia CAI:

1. Does CAI impact PETE majors' Content Knowledge (CK) of teaching the tennis serve?
2. Does CAI impact PETE majors' use of Pedagogical Content Knowledge (PCK) of teaching the tennis serve?
3. Does CAI impact PETE majors' observation skill or skill analysis on the tennis serve?
4. Does CAI impact PETE majors' teaching of task sequences for the tennis serve?
5. What are the perceptions of PETE majors toward using CAI?

Significance of the Study

This study is among the first efforts to determine the effects of multimedia CAI tennis CD-ROMs in a PETE program. In doing so, this study contributes to the literature in at least two ways:

1. This study extends the work of using CAI in a different setting.
2. This study is the first effort to investigate the effects of multimedia CAI tennis CD-ROMs on Content Knowledge (CK), Pedagogical Content Knowledge (PCK), and Skill Analysis levels in a PETE program.

Limitations of this study

This study is one the first attempts to determine the effectiveness of multimedia CAI at the collegiate level for PETE majors. However, the study has the following limitations, which should be carefully considered:

- 1- The study is limited by the subjects' entry characteristics such as gender, age, cognitive level, and previous experiences.
- 2- The study is limited by the quality and content of multimedia tennis CD-ROMs.
- 3- The study is limited by the measurement methods and procedures applied within the measurement process.

Delimitations of the Study

In addition, this study has the following delimitations:

1. Subjects will be delimited to undergraduate PETE majors.
2. Selection of samples will be delimited to only participants who give permission for data collection.
3. This study will be delimited to teaching only the tennis serve.

Basic Assumptions

In this study, it is assumed that results will reflect the effects of CAI on PETE majors' teaching of the tennis serve. In addition, students will be expected to try hard and be motivated to learn.

Definition of Terms

1. Computer-Assisted Instruction (CAI): A kind of tutorial implication in which a computer helps the learner(s) to present material and acts a tutor. Using a branching model of lessons in this process, the computer presents information, asks questions, and gives feedback.

2. Content Knowledge (CK): A special subject matter that provides information about the content to be learned. For example, grip, ready position, swing, contact, and follow through phases are the specific content knowledge in tennis serve.

3. Pedagogical Content Knowledge (PCK): A special amalgam of content and pedagogical knowledge. Teachers provide PCK by using metaphors, demonstrations, cues, and feedback (Shulman, 1987). For example, shake hands with the racket, reach for the sky, give a high five, and racket arm crosses the body and makes an X are specific cues that are used for providing pedagogical content knowledge in tennis serve.

4. Interactive Tennis: Computer software that provides a comprehensive approach to teaching tennis. This program is a computer tutorial that includes information and quizzes on equipment, rules, strokes, etiquette, and strategies, as well as videos of top professionals explaining and demonstrating the basic strokes in tennis. Interactive Tennis was designed as a tutorial for PETE majors (Petrakis, 1996).

5. Tennis Task Analysis: A problem-solving program that promotes the development of observation skills of physical education students and teachers. It was designed to improve basic skills of tennis by using concept mapping, restructuring tasks, and videos (Petrakis & Konukman, 1999).

6. Task sequence: A practical order of teaching a skill that determines the content and organizational aspects of the task. A teacher follows these teaching patterns when she/he teaches skills in a sequential order. Task sequence provides information about what task is to be performed and the organizational arrangements of the tasks to be performed (Rink, 2002).

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this study is to determine the effects of multimedia computer-assisted instruction (CAI) on PETE majors' teaching of the tennis serve. Chapter two will review and discuss the following topics to have a better perspective about CAI in the literature:

- Technology and teacher education;
- Definition of CAI;
- CAI in general education;
- CAI in elementary and secondary physical education;
- CAI in PETE and kinesiology courses;
- CAI in collegiate basic instruction programs (BIP);
- Pedagogical Content Knowledge (PCK) in teacher education;
- PCK in physical education and Physical Education Teacher Education (PETE);
- Skill analysis in PETE programs;
- Students' attitudes and perceptions toward CAI;
- Students' attitudes and perception toward CAI in physical education and PETE.

Technology and Teacher Education

The rapid improvement in information technology and other technological advancements in society have had major effects on teacher preparation programs. Imig and Switzer (1990) state that the advancements in information technology will fundamentally change the nature of teacher preparation programs, because the majority of instructional environments contain interaction among students, teachers, and information given to students. Furthermore, technological implications may change the nature of these interactions in many ways, including the ways the

information can be obtained, manipulated, and demonstrated in a content-specific teaching and learning environment.

Recently, information technology has played many roles in helping teacher education programs. There are several publications and research studies that describe courses and programs about pre-service teachers and technology with a growing body of literature in both qualitative and quantitative research (Willis & Mehlinger, 1996).

Information technology can support teacher preparation programs in several ways, such as in the method courses, foundation courses, different subject matters in the teacher education curriculum, and the student teaching experience. White (1991, 1994a, 1994b) used simulations and databases in a social studies method course. In these courses students were required to create lesson plans and apply them using technology in their microteaching. In addition, they established professional development school (PDS) sites, and in-service teachers provided hands-on technology activities to use in method courses for pre-service teachers.

There are also some good examples of the application of information technology to foundation courses. Pugh (1993) developed a software called “electronic classroom” and “roundtable” to promote dialectic thinking; i.e. the ability to understand different views in a critical reading course. This software helped students to understand certain case studies via simulations.

Different subject matters in the teacher education curriculum have also taken advantage of using information technology in their curriculum. Videodisc technology was developed at the Ohio State University PETE Program to teach physical education majors how to analyze sport-specific skills (O’Sullivan et al., 1989; Stroot et al., 1991). In addition, the TECH (Technology in Early Childhood Habitats) program at the University of Delaware organized computer courses for pre-service teachers to teach computer use for early childhood education in many ways (Caruso et al., 1994).

Moreover, information technology has begun to change the nature of traditional student teaching activities. Telecommunication and network systems especially support student teachers in many ways. The University of Virginia model (Bull et al., 1989; 1991) showed an exemplary way of how telecommunications can be transformed to create a link between student teachers,

faculty, and cooperating in-service teachers. This model used computers and the Internet to provide electronic mail conferencing between local and international communities with electronic data base support.

Consequently, information technology, including CD-ROMs, interactive videodiscs, teleconferencing, electronic mail, and microcomputers with hypermedia/multimedia programs has been part of teacher education programs in several ways. Computer assisted instruction is just one of these technological applications.

Definition of CAI

Today, a wide variety of CAI programs are available in different subject matter from preschool to college levels as well as in business and adult education courses. CAI can be classified into five categories in terms of functional aspects (Kelly, 1987; Lockard, Abrams & Many 1997; Petrakis, 2000; Volker, 1987): drill and practice, tutorials, simulations, instructional games, and problem solving programs.

Drill and Practice

Drill and practice is one of the better-known types of instructional models used in education. This type of program helps learners to remember previously taught subject matter and the computer program provides information on a specific topic by asking a series of questions. Drill and practice program emphasizes content that has already been covered rather than new material. In this process, mastery of learning is an important key element and the learner must reach a level of proficiency to progress to the next problem or level. Math Blaster, Mental Math Games, Math Wizard, Scholastic Math Shop Series, and Punctuation are good examples of drill and practice programs in CAI.

Tutorial Programs

The main purpose of tutorial programs is to tutor or instruct. Although this type of program is similar to drill and practice programs in many ways, tutorial programs provide new material to the learner, by presenting information, asking questions and giving feedback. In this process, the learner has a more active role via question and answer. The learner has more

opportunity in this system than just entering the answer. After each answer, the computer reviews the question or questions asked in different way. In addition to this, the program may track the progress of learner and change the difficulty of questions based upon the learner's previous performance. Tutorials also can be further classified into linear and branching types. In linear tutorials, all students follow a single pathway. Every student must answer the same questions in their own pace regardless of performance outcome. Conversely, branching tutorials provide alternative pathways according to the learner's answers. If a learner reaches mastery in a content, the program branches to the next content. The Geometry Series for Macintosh, some foreign language software programs such as French and German, and "Interactive Tennis" (Petrakis, 1996), are examples of tutorial programs in CAI.

Simulation Programs

Simulation programs are interactive models about a phenomenon or an event that provide an opportunity to manipulate variables. Thus, a student reads or learns a new scenario and implements his/her decision based on the information given. Then, the simulated environment changes based on these decisions. Simulations can be defined as the most sophisticated CAI programs because the computer provides a wide variety of pathways and the learner takes an interactive role throughout the simulations. Simulation programs are very helpful in situations where the real event or learning environment is dangerous to manipulate in a classroom environment. Thus, students are confronted with real-life situations in a safe interactive learning environment. One of the basic ideas of simulation in education is to provide a discovery-learning environment. There are a wide variety of simulation programs available. These include flight simulations for pilots, "Decisions", which is a social studies program that provides simulations for grades 5-12, and "Great Ocean Rescue", which is a video-disc program that provides simulation about environmental protection in marine life.

Instructional Games

Instructional games provide content in a game environment. The main purpose of the game is to teach and reinforce the content. This process is determined by a set of rules and the learner must be very competitive to reach target outcomes. One of the main advantages of games

is their use of sounds and graphics to provide a fun learning environment. Thus, games may serve as motivation device if they are selected carefully for instructional objectives. Moreover, educational game software offers a wide range of learning outcomes and it involves the learner in active mental preparation. Tennis and Golf games are good examples of instructional games.

Problem Solving Programs

Problem solving programs emphasize the development of critical thinking skills. This program provides information and data that can be used by the learner to determine the answers to problems. The main idea of the first problem solving programs was to create an environment in generic problem solving skills and then transfer this ability to other problems. Trial and error, elimination, and pattern searching are some examples of the first problem solving programs. Recent programs place much more emphasis on attention, concepts, and procedures to solve specific problems. “Tennis Task Analysis” (Petraakis & Konukman, 1999) and “Math Connections”, a program provides matrices, graphs and tables about Algebra are both examples of problem solving programs.

CAI in General Education

Although computers have been used more than 50 years for different purposes, the real intervention of computers into school system for the past two decades has produced different results in terms of instructional effectiveness and student learning. Recently, there has been a growing body of literature in search of the effectiveness of computers and CAI on student achievements from preschool to college level and adult education. Therefore, the purpose of this section is to review the effectiveness of CAI in general education within different subject matters.

Computers are becoming very popular among the families for better education of children in many ways. Especially new reading programs are helping to read and spell for the kids who have learning disabilities. Now according to US News World Report Magazine (April, 2001) families and teachers are turning a computerized spelling and reading program that is called Fast ForWord instead of standard reading workbooks. This program uses video-game formats and artificial speech to help kids to recognize sounds within a word and connect them to letters.

Besides, more than 10,000 schools purchased other computer programs such as Earobics, and the Waterford Early Reading Program to help children who have attention deficit disorder.

Overall, the effectiveness of CAI in education can be studied in terms of students at risk and with disabilities, as well as students' subject-matter achievement, problem solving abilities, attitudes and perception, and learning retention and speed (Lockard, Abrams, & Many, 1997). It is very interesting that there have been plenty of research studies in the literature comparing subject matter achievement of students using CAI versus traditional teacher instruction or regular instruction (Din, 1996; Kulik & Kulik, 1991; Liao, 1992; Salerno, 1995; Shute & Miksad, 1997; Swan et al., 1990; Weller et al., 1998; Wilson et al., 1996).

Student at Risk and with Disabilities

Recently, CAI has become an acceptable instructional strategy to provide several academic outcomes for at-risk students and those with disabilities. Even though there has been research on the effects and implications of CAI on students without disabilities, there is limited research evidence about the effects of CAI on students with disabilities.

Ross et al., (1991) assessed the effects of CAI on students' attitudes toward school, grades, computer skills, standardized test scores, and teacher evaluations using the Apple Classroom of Tomorrow (ACOT) program. Subjects were at-risk seventh grade students. Results showed that the CAI group was successful in math and reading compared to the control group. However, they reported that some academic achievements were lost and students remained at risk because of lack of on-going computer use and limited access to computer lab after the two-year experiment.

Considering the importance of time and on-task behaviors in CAI, Salerno (1995) examined the mathematics achievements of at-risk fifth graders. In this study, students were randomly assigned to three groups: extended computer time; extended time on-task, and control group. All students participated in CAI, but the extended time computer group used an extra 60 minutes per week with CAI, and the extended time on-task group used special workbooks with an equal amount of instructional time independently. The study's author used ANOVA to determine the effects on treatment and gender. The results indicated that there was a significant difference in achievement between boys in the extended computer time group and extended time

on-task group with special workbooks. Furthermore, girls in CAI with extended time group performed better than time-on task group with workbooks but not at a statistically significant level.

In other study, Wilson et al., (1996) compared the effects of CAI versus teacher-directed instruction on the multiplication skills of four elementary students with learning disabilities. Authors compared two interventions on opportunities to respond and success rate. A single-subject, alternating treatment design was used for data analysis. Results showed that the teacher-directed instruction group performed better on opportunities to respond and success rate than the CAI group.

Weller et al., (1998) conducted a study to determine the achievement gains of low-achieving students using CAI versus regular instruction in fifth grade. Using a pretest and posttest design they compared the daily reading and mathematic achievements scores of 63 low-achieving students in the CAI group and 48 low-achieving students in a control group. The students' scores were analyzed by analysis of covariance with pretest scores. The results indicated that CAI group means were significantly higher than with reading only.

Although there has been research about the effects of CAI on students' achievement from elementary school through the college level, there is limited information about the influence of CAI on academic skills of preschool children with disabilities (Wilson et al., 1996; Woodward & Reith, 1997). Most recently, Hitchcock and Noonan (2000) designed a single case study to determine the effects of CAI on early academic skills of five preschool students with disabilities. Authors compared a CAI group to a Teacher-Assisted Instruction (TAI) group based on three primary skills: matching shapes, colors, and numbers or letters. Results showed that both instructional strategies produced significant gains and CAI was either equal or superior to TAI across all skills and participants.

In brief, similar to other subjects matter, research on the effectiveness of CAI on students' achievement with at-risk students or students with disabilities have produced different and inconsistent results that did not support CAI as an instructional tool or strategy.

CAI in Students' Subject Matter Achievement

Researchers have conducted several meta-analytic studies to understand the effectiveness of CAI. Kulik et al., (1980) reviewed fifty-nine research studies using meta-analytic techniques about college teaching. They found that CAI made a small but significant contribution to the achievement of college students with positive attitudes toward the subject matter. In addition, Liao (1992) conducted a meta-analysis to synthesize the effects of CAI on cognitive outcomes from thirty-one studies in different subject matters and ages. He found that 23 (74%) of the research studies favored the CAI group over the control group.

In another study, Khali and Shashaani (1994) used meta-analytic techniques to examine thirty-six studies and found that although CAI increased student achievement in subject matters, time spent with computers was a significant variable for student achievement. Therefore, they concluded that the most effective duration time was four to seven weeks and the effects of CAI disappeared when it used less than three weeks. Moreover, researchers concluded that older students got more benefit from CAI compared to younger ones.

Most recently, Christmann et al., (1997) conducted a meta-analytic technique to compare the effects of CAI on the academic achievement of secondary students in different subject matters versus traditional teaching methods and traditional teaching methods supplemented with CAI. This study compared twenty-six studies and found that students who received traditional instruction supported with CAI gained higher achievement than those taught with traditional teaching methods.

Using an ethnographic design, Perzylo and Oliver (1992) performed a study to investigate the use of an interactive multimedia CD-ROM in a class of 32 elementary school children. The study used The National Geographic Society Mammals Multimedia Encyclopedia (1990) in a classroom research activity for four weeks. Researchers used field notes, students' summary papers, and interviews for gathering data. The results showed that students found CD-ROM intervention easier and more efficient than traditional use of other educational resources.

Shute and Miksad (1997) examined the effects of CAI on cognitive development for verbal, language, and math skills in preschoolers. Authors compared CAI to traditional teaching methods. Fifty-one children were randomly assigned into three groups according to level of

computer involvement. The levels of involvement for the groups were: substantial, minimal, and teacher instruction only (control group). Pretests and posttests were used to compare student achievement during the eight-week period. The results showed that CAI successfully increased student achievement in verbal and language skills but not in math skills.

Erdner et al., (1998) conducted a study to examine the effects of CAI on the reading skills of first graders. Using a quasi-experimental design authors compared a group of students supplemented with CAI to a traditional classroom reading program. They used a treatment by gender ANOVA design to assess changes in reading skills. Results were statistically significant with only males having an average increase when using CAI.

Finally, Saucier et al., (2000) compared the effect of CAI and Written Nursing Process (NP) case study strategies on critical thinking skills in undergraduate family nursing clinical course students. The study used a pre-test and post-test design and 153 students were randomly divided into two groups. The findings showed that CAI as an intervention produced equal outcomes to the traditional NP program in terms of critical thinking skills. However, CAI provided some advantages over the traditional method in time efficiency and student satisfaction. In brief, research on the effectiveness of CAI on students' subject matters achievement has produced different and inconsistent results.

Problem Solving Abilities

Problem solving, or critical thinking, is one of the cognitive outcomes that CAI is meant to improve for many students. Using a meta-analysis method Liao (1992) found that 23 of 31 research studies favored CAI over traditional instruction, especially in the areas of planning skills, logical thinking, reasoning, and general problem solving skills.

Funkhouser and Dennis (1992) studied the effects of a problem solving CAI program on high school students' geometry and algebra skills. They found that the CAI group performed better on problem solving skills whereas the control group gained better scores in solving word problems. In recent research, Bernard-Opitz et al., (2001) studied the influence of CAI on social problem solving skills in children with Autism versus their non-disabled peers. Eight preschool children with Autism and eight preschool children without disability participated. Authors used repeated measures of ANOVA and the dependent variable was the number of novel ideas

produced as a social problem solving skill. Results showed that compared to children without disabilities, children with Autism had a significantly lower number of novel ideas and normal children produced more novel ideas.

Learning Attention and Speed

In general, CAI is time effective for instructional purposes in the classroom due to characteristics such as being regularly paced and learner controlled as well as providing immediate performance feedback (Krein & Maholm, 1990; Kulik et al., 1980; Lockard, Abrams & Many 1997; Petrakis, 2000; Steffen, 1985).

Kulik et al., (1983) reported that four of five research studies in CAI on students' retention produced better retention rate and time; however, these studies had a small sample size and were not sufficient to produce statistically significant results.

In summary, the effects of CAI on students' achievement and learning produced mixed and inconsistent results for different subject matters in general education. Although there is some evidence that CAI can produce better academic outcomes than traditional or teacher directed instruction, we should consider and ask some critical questions to determine its effectiveness rather than media comparisons like CAI versus traditional teaching. At this point, it is very important to note that there are other factors or confounding variables that may have an effect on students' learning and achievements in different setting and circumstances such as the type of CAI, subject matter to be studied, characteristics of learners, level of student engagement, or academic learning time. Finally, researcher should ask very carefully "which" type of CAI for "whom" and "what conditions" to understand better outcomes of CAI.

CAI in Elementary and Secondary Physical Education

Nowadays computers can be used by physical education teachers in three ways; utilities, assessment, and Computer-Assisted Instruction (CAI) (Silverman, 1997). The use of computers as utilities is the most common application in physical education classes. At present, many physical education teachers use computers for managerial purposes such as data management, record keeping, attendance, planning, and communication with parents (Lambdin, 1997; Mohnsen, 1997; Mitchell & Hunt, 1997).

Assessment is the second important purpose for the use of computers in physical education activities. Physical education teachers use computers for skill and fitness assessment in a wide variety of ways. Bonnie's Fitware (Mohnsen, 1995) and Motion Software (1994) are good examples of this. Bonnie's Fitware helps students and teachers record fitness data, and provides information about their yearlong progress. By using Motion Software students analyze their strokes using biomechanical principles.

Although computers have been used in physical education classes in many ways, there is limited research evidence about the effectiveness of CAI in K-12 physical education classes. Up to date, there have been only three research studies completed about the effects of CAI on K-12 physical education classes. Research completed in K-12 physical education indicates that CAI has produced positive outcomes in female junior high schools students' volleyball skills (Wilkinson et al., 1999) and secondary students' badminton knowledge (Skinsley & Brodie, 1990). However, there is only one research study about CAI in elementary physical education classes and this study found no significant effect of CAI on teaching tennis rules, scoring, and terminology to fifth grade students (Alvarez-Ponns, 1992).

Wilkinson et al., (1999) examined the effects of a volleyball CD on cognitive and psychomotor skills of 69 junior high school girls. Students were randomly selected to be in the experimental and teacher instruction groups. Repeated measures of ANOVA were used to determine the effects of the CD on the students' learning. Students completed pre and post skill tests and written cognitive tests. In addition, game play was videotaped during a tournament and successful and unsuccessful trials were recorded. Results showed that although students in both groups improved their forearm pass, set, and underhand serve, the CAI group obtained significantly higher scores in the forearm pass and had more successful passes/serve, sets/serve, and contacts/serve during game play. Moreover, both groups improved significantly in their knowledge test, but there was no significant difference between the groups.

Skinsley and Brodie (1992) studied the effectiveness of CAI on the cognitive knowledge of 12 years old male students' badminton knowledge. A total of 42 students were divided into two groups as CAI and teacher instruction according to their knowledge and badminton ability. Both groups were taught the same badminton unit. Using a pre and post test design with

ANOVA, results showed that both groups improved their test scores considerably but there was no significant difference between the two groups. However, the CAI group retained information better with a mean score of 6.8% higher on the post-test than teacher instruction group.

The only research study about the use of CAI at the elementary school level was conducted by Alvarez-Ponss in 1992. This study explored the effectiveness of a CAI program in teaching tennis rules, scoring and terminology to fifth grade students. CAI was compared to the traditional teaching approach and data were collected using a pre and post-test ANOVA design in a five-week tennis unit. Although both groups improved their scores in the posttest, the results showed that there was no significant difference between the groups. Briefly, very limited research has been completed in K-12 physical education classes, and these studies have produced different results in terms of the effectiveness of CAI.

CAI in PETE and Kinesiology Courses

Technology will be an important concept in the future of physical education teacher education programs in the world. Unfortunately, in many ways, PETE programs have been slow to join the technological revolution, while the foundation disciplines such as biomechanics and exercise physiology have taken advantage of the recent developments in technology (Sharpe & Hawkins, 1998).

However, there are several good examples of the intervention of technology into physical education programs. The use of electronic mail, list serves, and the World Wide Web has led to important developments in PETE programs. USPE-L, sponsored by Virginia Tech, and PHYSED-L, sponsored by University of Illinois at Urbana-Champaign, are the most well know electronic mail listservs that are subscribed by physical education teachers. These listservs provide an information exchange and forum between the members in terms of different topics and issues for physical education programs and physical educators (Elliott & Manross, 1996a, 1996b). In addition, the World Wide Web brings different perspectives to physical educators with unique aspects. PE Central, developed by Virginia Tech (URL: <http://www.pecentral.org>), has become very popular among college physical educators, physical education majors and physical education teachers. This web site provides plenty of information about lessons, plans, equipment, and assessment.

Computer Assisted Instruction (CAI) is one of the good examples of technology's implications in physical education programs. The use of CD-ROMs can contribute a self-paced and interactive environment for teaching and learning in certain subject matters. However, there is no practical and empirical research evidence of using CD-ROMs in PETE programs until now.

The majority of the research on CAI has been conducted in kinesiology and athletic training courses. Some of these research studies have found that CAI has a positive effect on both undergraduate athletic training courses (Buxton et al., 1995; Chen et al., 1995) and a statistics course for physical education majors (Whitaker, 1990). However, two research studies found no significant effect of CAI on undergraduate physical education majors' knowledge in biomechanics courses (Boysen & Francis, 1982; McPherson & Guthrie, 1991).

Research in Athletic Training Courses

To date there have been three research studies about the effectiveness of CAI on undergraduate athletic training courses. Buxton et al., (1995) compared the effects of an Interactive Athletic Training Computer (IATEC) with a traditional reading method. Participants (N=34) were randomly assigned to four different treatment groups as IATEC, reading, IATEC/Reading, and control group. All but the control group received an hour intervention Q-angle. Using pre and post-test measurements with ANOVA results showed that IATEC/reading and IATEC group were significantly higher than other groups.

Chen et al., (1995) used the same program, IATEC, to investigate the effectiveness of CAI. They compared IATEC program to a textbook about the assessment of the quadriceps angles on a human model. Thirty-two subjects were randomly assigned to four treatment groups as IATEC, textbook, IATEC and textbook, and control. All participants completed pre and post oral practice tests about assessment of quadriceps angles and received an hour intervention, with the exception of control group. A one-way ANOVA with post hoc test showed that the IATEC and textbook combination group produced better results.

Deere et al., (1995) examined the knowledge and retention of knowledge comparing two different instructional strategies. Authors compared CAI and Traditional Lecture Method (TLM) about anatomy of the knee joint. In total, thirty-six students participated using a posttest control design with two days and after five months retention period. Authors used a t-test to compare

knowledge of groups. Results showed that there was no significant difference between the groups two days after instruction and also no significant differences were found five months later for retention.

Research in Biomechanics Courses

Research in biomechanics courses produced different results and did not support CAI as an instructional strategy. Boysen & Francis (1982) conducted a study to determine the instructional effectiveness of a computer lesson in biomechanics. In total, thirty-six students were randomly assigned to control (work sheet) or experimental PLATO groups. The score of midterm examinations were used to determine the differences between the groups using an independent t-test. Results showed that there was no significant difference between the groups.

McPherson and Guthrie (1992) implemented a study to evaluate CAI program in an undergraduate biomechanics course. 45 students were randomly assigned into two groups as CAI and lectures versus lecture only. Theoretical competency tests were given to students' at the end of the units. A paired t-test was used to determine if significant individual differences existed between treatments and an ANOVA was used to find out differences between the groups. Results showed that there was no significant difference between treatments and groups.

Research in PETE Courses and Different Subject Matter Courses

There is limited research on the effects of CAI in PETE courses. Research in PETE courses has been limited to elementary physical education method courses (McKethan et al., 2000, 2001), a statistics course for physical education majors (Whitaker, 1990), an exercise physiology course (Adams et al., 1989), and an undergraduate kinesiology course (Lease, 1981).

Lease (1981) conducted one of the first studies to determine the effects of CAI on the kinesiology knowledge of physical education majors. The purpose of the study was to develop and implement a series of CAI programs in an undergraduate kinesiology course about the mechanical analysis of motion. The author developed a series of four CAI programs using the BASIC Plus 2 language. Sixteen subjects participated to evaluate effectiveness of CAI programs. To measure the effectiveness of the programs a pretest and posttest was developed for each CAI program and each pretest was correlated with the corresponding posttest to determine the

relationship of the content of tests. The study showed that results were significantly related in three out of four programs. Author concluded that CAI can help students to improve their knowledge of kinesiology.

Adams et al., (1989) using a quasi-experimental design, compared the effects of voluntary CAI versus required CAI on physical education majors' exercise physiology knowledge. Participants were enrolled in three exercise physiology courses over a three-semester period. The control group (n=28) did not receive any CAI in the first semester period. During the second semester the voluntary CAI group (n=44) participated in the condition of voluntary use of CAI. Finally, the mandatory CAI group (n=27) received CAI in the third semester. A multiple choice 50-item knowledge test was administered at the end of each semester. One way ANOVA was used to determine if significant differences existed between the groups. Results indicated that the mandatory CAI group had better achievements than the control and voluntary groups. There was no significant difference between the control and voluntary CAI groups.

Whitaker (1990) made the comparison of three different instructional strategies on physical education majors' knowledge of statistics. These were CAI, Tutor Retrieval Text (TRT), and Programmed Lecture (PL). During the study, 47 PETE majors were randomly divided into three groups. The author used a pretest/posttest experimental design. After a two-week period of three hours training, subjects completed a 57-question post knowledge test. An ANOVA with repeated measures, followed by a post hoc Tukey test, was used to determine differences between the groups. Results of this study indicated that there was no significant difference between the groups. The PL group was less efficient. Moreover, there was no difference between the CAI and TRT groups.

McKethan et al., (2000) analyzed the effects of multimedia computer instruction on learning and teaching cues of manipulative skills: overhand throw, catch, and kick. All of the subjects were elementary education majors enrolled in a course on teaching elementary physical education for children. The subjects were divided into two groups; the experimental group (n=45) received information about manipulative cues via CAI, while the lecture group (n=52) received the same information via teacher instruction. All participants completed fill-in-the blank answers to determine critical cues for manipulative skills as a pre and posttest measurement. A

multivariate analysis of variance (MANOVA) with repeated measures, followed by a Wilks' Lambda was used to determine if there was a difference between the groups. Results showed that although the lecture group scored significantly higher than the CAI group on the posttest, there was no difference between the groups on specific cue descriptions.

The most recent research, McKethan et al., (2001) replicated the same study and examined the effects of multimedia software instruction on learning and teaching cues of manipulative skills on preservice physical education teachers. In all, 44 subjects were divided into a control group (n=13), a multimedia group, (n=13) and a lecture group (n=18). The multimedia group obtained instruction about overhand throw, catch, and kick using CAI, while the lecture group completed traditional teacher instruction. The control group did not receive any instruction about skills. Before and after interventions, subjects completed a fill-in-the blank test to determine critical cues for manipulative skills. A multivariate ANOVA with repeated measures was used to determine if there is difference between groups following with a Tukey's post hoc test. Results showed that although the multimedia and lecture groups performed better than the control group in description of critical cues, there were no significant differences between the multimedia and teacher instruction groups.

In conclusion, CAI in PETE method courses and different subject matter courses produced inconsistent results similar to other research studies in the literature.

CAI in Collegiate Basic Instruction Programs (BIP)

There have been only three research studies to determine the effects of CAI in collegiate basic instruction programs until now. The first research study in collegiate basic instruction programs was conducted by Steffen and Hansen (1987) to determine the effects of CAI on cognitive and psychomotor skills of bowling. The authors compared CAI versus traditional instruction (TI) with 90 students. The TI group (n = 49) consisted of 26 males and 23 females, while the CAI group (n = 41) had 26 males and 16 females. The TI group received 180 minutes of class time about the history, equipment, rules, and scoring of bowling. Moreover, approximately 270 minutes were spent for skill practice time. The subjects in the CAI group received 180 minutes of computer instruction time about the same topics, with 225 minutes spent for skill practice time. The authors analyzed bowling skill, bowling knowledge, and students'

perception toward CAI. Bowling skill ability was analyzed by pretest/posttest game scores with analysis of covariance. Bowling knowledge comparison and attitudes toward CAI were determined by a pretest/posttest 54-item multiple-choice test and an attitude test using an independent t-test. The results indicated that bowling scores of the CAI group were significantly higher than those of the traditional group, but there was no significant difference in knowledge test. In addition, students had a more positive perception toward CAI.

Kerns (1989) examined the effectiveness of CAI on teaching tennis rules and strategies in a basic instruction tennis course. The control group (n = 24) received traditional instruction about tennis rules and strategies, whereas the experimental group (n = 19) received the same information via CAI after an 8-week program with 24 class meetings of 50 minutes each. A written test was used to determine learning as pretest and posttest measurement. A two-factor analysis of variance with repeated measures was used to determine differences between the groups. Results of the study showed that there was no significant difference between the groups.

The most recently, Konukman et al., (2001) examined the effects of CAI on tennis forehand and backhand knowledge, and psychomotor skills in a collegiate basic instruction tennis course. The treatment group (n = 20) received CAI for 4-week about the tennis forehand and backhand knowledge and skills. The Interactive Tennis (Petrakis, 1996) multimedia CD-ROM was used as an intervention for the experimental group. The control group (n = 22) received teacher instruction for 4-week. All participants completed pre and posttest for forehand and backhand knowledge and psychomotor skill tests. An updated version of Hewitt's comprehensive knowledge test was used to measure cognitive forehand and backhand tennis knowledge. Furthermore, Hewitt's tennis achievement test was used to evaluate forehand and backhand psychomotor ability. Finally, students' performance in forehand and backhand strokes was determined with a qualitative data analysis using a videotape and skill checklist chart. A multivariate analysis of variance with repeated measures was used to determine if a difference existed between the groups and within the groups. The results indicated that although there was no difference between the groups, the CAI group differed significantly within the group in the amount of change from the pre to posttest in the forehand and backhand knowledge test (KT),

the forehand skill test (FST), the backhand skill test (BST), and the qualitative backhand test (QBT). There was no significant effect on the qualitative forehand test (QFT).

In summary, there is limited research about the effect of CAI on basic instruction programs at the collegiate level, and these studies have produced inconsistent results about the effectiveness of CAI as an instructional strategy.

Pedagogical Content Knowledge (PCK) in Teacher Education

The study of teachers' knowledge and cognition has become very popular in the last two decades of educational research and teacher education. In the early behaviorist tradition, the research emphasis was on the observable behaviors and skills of teachers and students. The emphasis on teacher cognition in teaching was affected by the growing research interest in the late 1960s social sciences and qualitative studies of classroom teaching (Carter, 1990).

At this point, teacher education programs focused on process-oriented studies via classroom management, how to plan and deliver lessons, positive reinforcement and effective feedback (Vickers, 1987). This information process approach focused on cognition and the mental process of teachers such as appropriate cues, rules, and routines in decision-making process. In the mid 1980s, the information process approach focused on the study of expert and novice teachers. A large amount of research examined expert and novice teachers about classroom organization, protocols, routines, and managing instruction (Berliner, 1986, Carter et al., 1987, 1988; Peterson & Comeaux, 1987)

First approach to teachers' knowledge traditionally focused on content knowledge (CK) and pedagogical knowledge (PK). Content knowledge is the form and procedures about the subject matter being told. On the other hand, pedagogical knowledge provides declarative and procedural knowledge that lead to classroom management skills (Perez & Saury, 2000).

Although early teacher education research emphasized the subject matter knowledge or content knowledge, a major research focus at Stanford University with Lee Shulman and his colleagues provided the first definition of Pedagogical Content Knowledge (PCK) in education and teacher education literature during late 80s. According to Shulman, PCK can be defined as "the special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (Shulman, 1987, p.8). In addition to this,

Shulman (1987) states that teachers provide PCK by using metaphors, demonstrations, cues and feedback in a specific content.

During the last two decades, there was an increasing research interest in teachers' pedagogical content knowledge in social studies (Gudmundsdottir & Shulman, 1987), mathematics (Carpenter et al., 1988; Marks, 1990), English (Grossman, 1988), college professors (Fernandez-Balboa & Stiehl, 1995), and science education (van Driel et al., 1998).

One of the early studies, Gudmundsdottir & Shulman (1987), examined the PCK of two social studies teachers: a novice and veteran teacher. Using a qualitative research methodology, interviews, tape recordings, field notes, and documents were collected during a period of 12 months. Authors pointed out that there was a special kind of difference between the novice and expert teacher and this was neither content knowledge nor pedagogy. They concluded that this was about pedagogical content knowledge of teachers that combine content, pedagogy, and learner characteristics in a unique way.

Marks (1990) studied the PCK in mathematic education. The author interviewed eight fifth-grade teachers about their teaching of equivalence of fractions. Six expert and two novice teachers were interviewed using a task based 45-90 minutes interview developed for a teacher assessment project at Stanford University. Using a qualitative data analysis, the results of the study showed that PCK in teaching equivalence has four components: subject matter, students' understanding of subject matter, media for instruction in subject matter, and instructional process for that subject matter. The author concluded that PCK comes from a wide variety of sources and educators should approach PCK in more than one way.

Fernandez-Balboa and Stiehl (1995) explored the interpretive frameworks that university professors used in their PCK construction. Ten distinguished university professors from different programs were interviewed for two hours. Using a qualitative constant comparison analysis, results indicated that college professors construct their PCK in similar ways, and five PCK components emerged from the study: knowledge about the subject matter, the students, instructional strategies, the teaching context, and one's teaching purposes.

In summary, although PCK is a new terminology in the educational research field, there is a growing body of research literature that emphasize the development and importance of PCK in different subject matters.

Pedagogical Content Knowledge (PCK) in Physical Education and PETE

Research on PCK in physical education and PETE has become an emerging research paradigm to investigate in the last decade. Using Amade-Escot's (2000) framework, PCK research in physical education and PETE can be categorized into three parts: a) Teacher cognition; b) How teachers acquire, elaborate and transform PCK; and c) Professional preparation of pre-service teachers.

In the early 90s, the first research studies in physical education focused on teacher cognition with knowledge and decision. In this model, research studies compared expert teachers versus novice teachers (Griffey & Housner, 1991; Housner & Griffey, 1985; Housner, Gomez & Griffey, 1993a, 1993b). In addition, some studies were focused on the structure of pedagogical knowledge and content was the main focus instead of PCK (Ennis, Mueller & Zhu, 1991; Rink, French, Lee, Solmon & Lynn, 1994). Studies comparing expert and novice teachers produced interesting results. One of the studies found that expert physical education teachers gave priority to content and had good transitions between activities (Griffey & Housner, 1991). In addition, these studies reported that expert teachers had a wide variety of knowledge with rich resources and they had a smooth control over the task and transitions compared to novice ones.

This research was followed by a group of studies that focused on acquisition, elaboration, and transformation of PCK. In these studies the main emphasis was the structure of pedagogical knowledge; categories of declarative and procedural knowledge were analyzed (Dodds, 1994; Housner; Rink et al., 1994; Rovegno, 1992, 1993, 1994). These knowledge structure studies found interesting results about pedagogical knowledge and its integration into subject matter knowledge. The results of these studies showed that use of pedagogical knowledge depends up on certain factors in a teaching and learning context, such as experience of the teacher, the students' level, students' reactions, and social support from a mentor (Graber, 1995; Sebren 1995). In addition, several studies on PCK emphasized the role of university and teacher

preparation curriculum for physical education students. (Fernandez-Balboa et al., 1996; Griffin et al., 1996; O'Sullivan & Doutsis, 1994; Metzler et al., 2000; Schempp, 1993).

Consequently, the research on PCK in physical education and PETE has gained importance in the last decade and there is a growing body of literature about the definition, elaboration, acquisition, and transformation of PCK in many ways. The following research studies in physical education and PETE will provide some of these perspectives in detail.

One of the earliest research studies, Walkwitz (1992) examined the effect of PCK on teacher feedback and student throwing skills. Two kindergarten teachers and their students (n=36) were the participants. The first teacher had softball experience and had completed numerous physical education courses during undergraduate education. In contrast, the second teacher had no softball teaching experience. A knowledge assessment was conducted about the overhead throw and it was found that the first teacher had a strong PCK compared to second one. Both teachers taught three overhand throwing lessons to kindergarten students. The teachers and students were videotaped during instruction, and the feedback statements of teachers were audiotaped. In addition, the students practice trials were analyzed via videotapes. Results of this study showed that the experienced teacher provided more prescriptive feedback toward specific body positions. On the contrary, the inexperienced teacher provided evaluative feedback that emphasized general body movement and was outcome oriented. Most interestingly, the students with the more experienced instructor produced more correct practice trials compared to those with the inexperienced teacher.

Rink et al., (1994) compared the pedagogical knowledge structures for effective teaching of undergraduate pre-service teachers and teacher educators in two different universities with different teacher education approaches in their course work. The pre-service service teachers were asked to complete a concept map about effective teaching in physical education. These data were compared with concept maps of teacher educators at two institutions. The number of words, the number of concepts, and the average number of words per concepts were used as quantitative measures. In addition, qualitative analyses were conducted to determine major concepts, relationships between concept, and the accuracy of the relationships. The results showed that more experienced pre-service teachers used more words for concepts than novice pre-service

teachers in the cognitive maps. Moreover, teacher educators used similar concepts and chunks within their maps.

Rovegno (1995) conducted a case study to determine a student teachers' pedagogical content knowledge and decisions about task content and progression. The author observed a nine-lesson volleyball unit in a third-grade and fourth-grade class and a five-week, two to three lessons per week, badminton unit in 11th and 12th grade. Data was collected via observation, interviews, and field notes and was analyzed using constant comparison and analytic induction. Results of this case study showed that student teacher pedagogical content knowledge in terms of dividing and sequencing subject matter can be explained as biomechanically efficient body position and playing games.

Schempp et al., (1998) examined the influence of subject matter expertise on teachers' pedagogical content knowledge. The subjects were 10 physical education teachers currently teaching in public middle schools. Using a qualitative method, each teacher was interviewed four times for approximately an hour, emphasizing the teacher's familiarity with two content areas as expert and non-expert with their experience teaching these subjects. The expertise of physical education teachers was assessed via a self-assessment expertise rating scale, background interview about the subject matter, and amount of experience. Results of this study revealed that expert subjects reported the most important problem as student motivation while non-expert teachers believed that they had difficulty finding appropriate activities. Moreover, both expert and non-expert teachers showed no differences in curricular selection, evaluation, and students' perceptions.

Kutame (1999) conducted a study to determine the influence of teachers' content and pedagogical content knowledge on student acquisition of a gymnastic skill. Seven experienced elementary school physical education teacher were recruited. There were three research questions in this study: What do teachers know about the cartwheel and how to teach it and how did they get that knowledge; How do teachers present the cartwheel task and provide feedback to more and less skilled children; and how do these children respond and what do they understand about cartwheel? The author used a multicase design with cross-case and cross-interview analysis. Data were collected during two 15-30 minute sessions teaching cartwheel unit. In

addition, semi-structured interviews, field observations, video and audio taping of classes, and a survey were used. Results of this study indicated that there were differences among teachers in content knowledge but not in PCK. In perhaps the most important result, the author found that the teachers who knew the content very well detect student errors more successfully than the teachers who were weak in content.

One of the most recognized research studies was conducted at Georgia State University by Michael Metzler and his colleagues in a longitudinal study. Metzler et al., (2000) assessed pedagogical knowledge of physical education majors in Physical Education Teacher Education Assessment Project (PETEAP). This project mainly assessed student teachers' pedagogical knowledge in classroom management, interaction with learners, knowledge, and assessment. Student teachers planned and taught six 10-minute micro lessons to children during method courses. Videotaped lessons were used to analyze data. This study used five types of data as evidence of PETE students' pedagogical knowledge: a) Checklist of preferred pedagogical practices in microteaching units such as set induction, pinpointing, skill feedback; b) Events and duration recordings such as informing tasks, extension tasks, games; c) The Qualitative Measure of Teaching Performance scale (QMTPS); d) Cooperating teachers' rating of pedagogical skills; and e) Written comments of university supervisors.

In general, the purpose of this project was to assess PETE students in three areas according to NASPE standards: a) motivation and management; b) communication; and c) planning and instruction. Overall, the results of this study indicated that PETE students performed improved managerial skills such as attention signal, checking for understanding, and setting equipment. In addition to this, cooperating teachers gave high scores to PETE students in certain areas such as specificity of feedback, clear objectives, and instructions. Finally, PETEAP data indicated that PETE students had moderate to strong improvement in instructional skills such as providing opportunities to respond and content development. However, some areas were not developed very well such as time management, verbal behaviors, and skill feedback pattern.

Most recently, Jenkins (2002) examined the pre-service teachers' PCK development during peer coaching in a PETE program. The main aim of this study was to describe the types of knowledge that pre-service teachers demonstrated during peer coaching activities. The

subjects were eight pre-service teachers enrolled in an elementary physical education method course. Subjects were trained for peer coaching strategies for physical education using a specific methodology. Each subject was paired with a coaching partner and taught eight lessons, using a qualitative methodology, data collected via daily written reports, audio taped observations, and post lesson conferences. Data were analyzed via a constant comparison method. Results showed that teacher-coach role promoted the development of PCK. Most interestingly, teachers focused on social behaviors of the children at the beginning and coaches focused on management skills. However, later on, PCK evolved from management concerns to subject matter development and environmental factors.

In summary, development and acquisition of PCK is a very complex process and PCK can be measured in different methodologies and perspectives in PETE. Amade-Escot (2000) states that PCK in physical education and PETE is very content specific and subjects and context are very important variables in this process. Overall, it seems that the emergence of different research methodologies is essential to find the specific meaning and role of PCK in physical education and PETE.

Skill Analysis in PETE Programs

Skill analysis is an important part of effective teaching in physical education as well as being an important competency for PETE majors to develop. According to Hoffman (1977) skill analysis can be defined as the systematic process of observing students' responses, and based on this observation, determining the differences between actual and desired skill responses.

Skill analysis is an essential capacity to have for every physical education teacher because physical education teachers must be able to recognize critical features of a skill or movement pattern to give immediate corrective feedback. Thus students' poor performance can be detected early and immediate feedback can help with student achievement for skill development and progress (Ciapponi, 1999; Morrison & Harrison 1985; Siedentop, 1988; Wang & Griffin, 1998).

Qualitative skill analysis can be defined as systematically observing human movement, and then making a judgment to provide the most appropriate feedback in order to improve performance (Knudson & Morrison, 1997). Many research studies showed the importance of

qualitative skill analysis training for preservice teachers to analyze motor skill performance. Research on qualitative skill analysis indicated that physical education teachers and preservice teachers who completed skill analysis training were significantly more successful than nontrained teachers (Ganstead & Beveridge, 1984; Kaminieski, 1980; Kniffin, 1985; Morrison & Harrison, 1985; Morrison & Reeve, 1988; Walkley & Kelly, 1989; Wilkinson, 1992).

Although many research studies have shown the importance of qualitative skill analysis training for physical education teachers, Morrison & Harrison (1997) state that there is limited inclusion of qualitative skill analysis into PETE method courses. In general, there are two approaches for qualitative analysis in PETE method courses: video approach and concept approach. Some of these video approaches are very sport-specific, and sport skills are divided into specific sequences and components to help learners (Morrison & Harrison, 1985; Wilkinson, 1992). On the contrary, the concept approach emphasizes biomechanical principles and knowledge such as body position and mechanics (Nielsen & Beauchamp, 1992; Satern et al., 1991).

Siedentop (1988) analyzed the results of skill analysis research conducted at The Ohio State University as a research paradigm and reported the following results:

- 1- Both video training and peer tutoring were effective to teach skill analysis for PETE majors if these competencies were taught directly.
- 2- Teaching critical elements is very important to subjects before doing an effective skill analysis study so participants can recall performance in their minds when observing a performance.
- 3- Being a skillful performer is not related to being a good skill observer and analyzer.
- 4- Students who had visual training with sufficient audio-visual cues learn better than those who observed the tapes without cues.
- 5- Producing skill analysis materials is a very time consuming process but if the materials are produced very carefully, intervention and training time is minimal.
- 6- It is very difficult to analyze skills in live settings and performance situations.
- 7- Completion of a kinesiology course in PETE curriculum does not affect skill analysis performance.

In addition to this, Morrison & Harrison (1997) analyzed the results of qualitative skill analysis research for a 20-year period and they concluded the following results from the literature:

1- Specific instruction provides an improvement to distinguish correct and incorrect performances (Kniffin, 1985).

2-The information process plays an essential role in skill analysis (Morrison & Reeve, 1992).

3- Correct and incorrect movement patterns provide improvements in analysis (Gangstead, 1984; Morrison & Reeve, 1988).

4-Teachers and instructors can teach qualitative analysis with multiple methodologies (Knudson, Morrison & Reeve, 1991).

5-There are 5 to 7% gains in students' post-test scores compared to pre-test scores (Hoffman & Armstrong, 1975; Morrison & Reeve, 1992).

6-Qualitative instruction strategies in lab studies are helpful in improving teaching skills (Kniffin, 1985).

7-Preservice students improved in providing corrective and evaluative feedback after a qualitative training program (Satern et al., 1991).

The literature review shows that there are numerous research studies on qualitative skill analysis. The following studies are only few of them to provide a better perspective in this area. One of the earliest research studies in skill analysis, Amstrong and Hoffman, (1979) examined the effects of teaching experience and knowledge of performance outcome on performance error identification. Experienced tennis teachers (n=40) were compared to PETE majors (n=40) based on the performer' s level of competence in the skill (PCI) and post response outcome produced by the response (POI) conditions. Twelve common forehand performance errors were presented to observers via 8-mm color film. Subjects were asked to complete an error detection test. The data were analyzed using a three way ANOVA. Results indicated that although experienced tennis teachers were more accurate in differentiating errors, there were no significant differences between the groups in PCI and POI conditions.

Morrison and Reeve, (1986) conducted a study to determine the effectiveness of instructional videotapes in teaching elementary education majors to analyze specific skills. Participants were 84 elementary education majors randomly divided into three groups. The control group (n=25) received no instruction in skill analysis while the experimental soccer group (n=23), and experimental throwing, catching, and striking groups (n=36) were instructed using a skill analysis videotape. All subjects completed a skill analysis test. One way ANOVA was used to analyze data, and the results revealed that the intervention effects were significant only for the throwing, catching, and striking groups. There was no effect on the control group and soccer group.

In another study, Morrison and Reeve (1988) investigated the effect of qualitative skill instruction on undergraduate elementary classroom teachers (n=61), physical education majors (n=25), and sport science majors (n=33). Subjects in three groups were randomly assigned into treatment conditions. Half of each groups members gained instruction about qualitative skill analysis via videotape and the rest of the members did not get any instruction. All subjects completed a skill videotape test that showed children performing skills, and they were asked to evaluate the correctness of the performance. The data were analyzed using a treatment by groups (3x2) ANOVA design. The results showed that there was a significant effect on treatment; the groups that received qualitative skill analysis training via videotape scored better than the uninstructed groups.

One of the first Interactive Videodisc (IVD) qualitative assessment programs was developed by Luke Kelly and his friends in 1986. IVD is a type of computer-assisted instruction that combines instructional functions of a computer with a visual laser disc. Walkley and Kelly (1989) designed a study to investigate the effect of an IVD skill assessment program on preservice and inservice teachers' qualitative skill analysis abilities in the overhand throw and catch. Pre-service physical education teachers (n=27) and in-service physical education teachers (n=27) were randomly assigned to three intervention groups: interactive videodisc (IVD), teacher-directed (TD), and self-directed (SD). Participants completed a pre and post skill assessment accuracy test. Data were analyzed with ANCOVA and results indicated that the IVD

and TD groups were superior to the SD group in overhand throw. Furthermore, the IVD group scored better in catching skills compared to the TD and SD groups.

Wilkinson's research (1996) provided a new approach to qualitative analysis of sport skills focusing on training and transfer effects. She examined the effects of a visual-discrimination training program on subjects' abilities to analyze over-arm throwing skill. In addition to this, she also examined the transfer effect on three related overarm skills and an unrelated skill: badminton overhand clear, tennis serve, and volleyball serve (related skills), and the standing long jump (unrelated skill). A pretest/posttest control group design was used in this study. Subjects were divided into a treatment group (n=13) and a control group (n=13). The treatment group received a visual discrimination program and the control group did not receive any treatment. Data were analyzed with two way repeated measures of ANOVA. The results indicated that there were no significant differences between the two groups in pretests. However, there were statistically significant differences between the groups' post-test scores for the overarm throw, badminton overhand clear, tennis serve, and volleyball serve, with the exception of the standing long jump.

Most recently, Kernodle and McKethan (2002) examined the effects of a computer based distance-learning program on qualitative skill analysis of preservice physical education and elementary education majors. 55 preservice physical education teachers and 64 preservice elementary education teachers were randomly assigned to four groups. First, as a part of the training protocol, all subjects were asked to detect errors in an incorrect throwing motion on a computer screen until the errors were effectively determined. Second, subjects completed an online skill analysis test on detection of errors in the overhand throw. Five days after the test, all subjects in four groups were asked to complete a retention test. Group one was a control group and it did not get any intervention. Group two received a video intervention observing a highly skilled model demonstration. Group three received text information only describing appropriate mechanics. Group four received both video and text information. The results of this study showed that for preservice elementary teachers the combination of video and text was the most effective treatment in retention phase.

In conclusion, the majority of research studies have emphasized the importance of qualitative skill analysis training for physical education teachers. Research on qualitative analysis of skill has demonstrated that subjects who participate in special training for skill analysis perform better in detection of errors compared to other participants who do not have training.

Students' Attitudes and Perception Toward CAI

Computers and computer-assisted instruction are gaining importance, and the integration of computers into teaching and learning environments is a very common trend in today's schools. In these circumstances, students' attitudes and perceptions toward CAI are essential factors for the students' achievements in CAI and the application of computers as a successful educational tool.

There are several studies to measure students' attitudes and perceptions toward CAI in literature. Kullik et al., (1983) analyzed ten research studies to determine students' attitudes toward CAI. Authors found that the majority of the students had a positive attitudes toward CAI compared to their regular classes.

The attitudes of preservice and inservice teachers toward CAI have been emphasized in some of the research studies. Fratianni et al., (1990) examined students' attitudes and perceptions in teacher education programs at University of Northern Iowa. Results showed only 19% of students felt that they were adequately prepared to implement computer technology in their teaching. In addition, 67% of students reported that an educational computing course should be required in teacher education programs. Moreover, they reported that students in mathematics and science programs felt more comfortable applying technology compared to social science, physical education, and music majors.

In another study Kraus et al., (1994) conducted a qualitative study to determine student teachers' perception of technology in a teacher education program. Eleven secondary student teachers from different programs participated as subjects. Student teachers were interviewed in a semi-structured format. Results of this study indicated that student teachers' perceptions of instructional technology were limited and focused on four basic themes: technology as a

managerial support, motivational tool, unreliable and difficult requirement for teachers, and technology as unknown.

Vermette et al., (1986) examined elementary school students' and teachers' attitudes toward computers in education. Students (n=116) and teachers (n=50) completed a teacher and student survey and six open-ended short answer questions. Results of this study showed that both students and teachers emphasized the educational value of computers but they were negative about the personal effects of computers. In addition, both students and teachers had negative attitudes toward computers in terms of dehumanization perspectives such as socialization issues.

A_kar et al., (1992) studied students' perception of computer assisted instruction environment and their attitudes toward computer assisted instruction. The subjects were 137 fifth-graders from two elementary schools. All students participated in a month period of computer assisted science instruction. After completion of a month of instruction, students completed two scales: attitudes toward CAI scale and CAI Environment Instrument scale. The results of this study showed that students had positive attitudes toward CAI and there were no significant differences between girls and boys.

In conclusion, results show that students' attitudes and perceptions of research in CAI have produced different results.

Students' Attitudes and Perception Toward CAI in Physical Education and PETE

Up to date there have been only limited studies to measure students' attitudes and perception toward CAI in physical education and PETE. One of the first studies to determine students' attitudes toward CAI was conducted by Steffen and Hansen in 1985. The main purpose of the study was to compare cognitive and psychomotor bowling scores in a collegiate basic instruction program. Subjects were 90 university students. As a part of this study all subjects completed the University of Iowa Student Perception of Teaching (SPOT) questionnaire, and the CAI group also completed a six-item questionnaire about perceptions toward CAI. The results of this study showed that students had very positive attitudes toward CAI. In addition, students in the CAI group indicated that they had better instruction than the traditional instruction group.

Alvarez-Pons (1992) examined the effectiveness of CAI in teaching the rules, scoring procedures, and terminology of tennis. Subjects were twenty-eight fifth grade students. Students'

attitudes toward CAI were assessed via an attitude questionnaire. Results of this questionnaire indicated that students in the CAI group had positive attitudes toward the use of computers. Moreover, the majority of the students in the CAI group reflected that they had an interest to learn other sport activities via CAI. However, some of the students reported that they would prefer being outside playing tennis and learning the rules.

Wilkinson et al., (1999) studied the effects of volleyball software on female junior high school students' volleyball performance. Participants were 69 junior high school girls in a 16-day volleyball unit. Students' attitudes toward using CAI were measured via a Likert scale, with responses ranging from "strongly disagree" to "strongly agree". Results of this study showed 75% of CAI group reported that using CD-ROM improved their performance in volleyball skills. In addition to this, 84% of the CAI group indicated that they had a better understanding of cognitive concepts such as rules of volleyball via CAI.

Summary

In summary, the purpose of this chapter was the review of literature to have a better picture of the research studies that have been conducted in the area of CAI, pedagogical content Knowledge (PCK), skill analysis, and students' attitudes and perceptions toward CAI.

CHAPTER 3

Methodology

The aim of this study is to determine the effects of multimedia Computer-Assisted Instruction (CAI) on undergraduate PETE majors' teaching of tennis serve. This chapter provides information about the methods used to collect data during the study including a) selection of subjects; b) variables; c) instrumentation; d) pilot study; e) experimental design; and f) statistical design.

Selection of Subjects

The subjects for this study were selected randomly from an undergraduate PETE program at Virginia Tech. Approximately 18 students enrolled in a PETE evaluation and assessment course were given the opportunity to participate. Subjects stratified by gender and then assigned randomly to three groups. These groups are the Computer-Assisted Instruction (CAI) group (n = 6), The Teacher Instruction (TI) group, (n = 6) and the Control (CG) group (n = 6). Permission to conduct this study was approved by Virginia Polytechnic Institute and State University, Institutional Review Board (IRB #01-283). Appendix F shows informed consent for participants

Variables

Dependent Variables

There are five dependent variables in this study. The first dependent variable is PETE majors' Content Knowledge (CK) of teaching tennis serve for the study. This variable was measured by a paper and pencil Tennis Serve Content Knowledge Test, which consisted of seventeen items. The second dependent variable is PETE majors' use of Pedagogical Content Knowledge (PCK) of teaching the tennis serve. The second variable was measured by a microteaching lessons via videotape recording. The third variable is PETE majors' observation skill or skill analysis on the tennis serve. This was measured by a tennis serve skill analysis video test. The fourth variable is the PETE majors' teaching of task sequence for the tennis serve. The fourth variable was measured via a paper and pencil task sequence test. Finally, the fifth variable

is PETE majors' perception toward CAI. This last variable was measured via a paper and pencil short answer questions.

Independent Variables

There are two independent variables in this study: Instructional methodology (Computer Assisted Instruction, Teacher Instruction) and time (pretest-post test).

The CAI group completed a sixty-minute instruction session about teaching the tennis serve. For this group, a doctoral student assisted students as a facilitator in the computer laboratory. CAI assists the learner(s) by presenting material and acting as a tutor. CAI uses computers to facilitate student learning. Students interact with computers at their own pace and the responsibility of the teacher becomes that of a facilitator or coach. One of the major roles of CAI is to direct the students' attention to different sections in a learning sequence without the assistance of a teacher (Petrakis, 2000). Two multimedia CAI tutorials, Interactive Tennis (IT) (Petrakis, 1996) and Tennis Task Analysis (TTA) (Petrakis & Konukman, 1999), were used as interventions in the study.

The first CAI program, Interactive Tennis, is computer software that provides a comprehensive approach to teaching tennis. This program is a computer tutorial that includes information and quizzes on equipment, rules, strokes, etiquette, and strategies, as well as videos of top professionals explaining and demonstrating the basic strokes in tennis. Interactive Tennis was designed as a tutorial for PETE majors in 1996 at the University of Nebraska Lincoln. (Petrakis, 1996).

The second CAI program, Tennis Task Analysis, is a problem-solving program that promotes the development of observation skills of physical education students and teachers. It was designed to improve basic skills of tennis analysis by using concept mapping, restructuring tasks, and videos for PETE majors in 1999 at the University of Nebraska Lincoln (Petrakis & Konukman, 1999).

The Teacher Instruction group (TI) received a sixty-minute teacher instruction session about teaching the tennis serve from main investigator as a comprehensive teaching method including demonstration, discussion, and drill. Appendix B shows tennis serve content teacher instruction outline. The content of instruction and practice was the same as the CD-ROMs'

content. Teaching of main investigator and computer instruction were videotaped and analyzed by a peer to determine procedural fidelity in both sessions. Procedural fidelity was reported as % 98. Finally, the Control Group (CG) did not get any intervention.

Instrumentation

The instrumentation section of the study consists of four main parts. The first part describes the tennis serve content knowledge test. The second part describes the tennis serve pedagogical content knowledge assessment. The third part gives information about the tennis serve skill analysis test and the tennis serve task sequence test. And finally, the fourth part describes the students' attitudes toward CAI.

Tennis Serve Content Knowledge Test

The first instrument was VTPE Tennis Serve Content Knowledge Test. Content Knowledge (CK) is a special subject matter knowledge that provides information about the content to be learned. A seventeen item multiple-choice test was developed by the main investigator measured tennis serve content knowledge (Appendix C). The purpose of this test was to measure knowledge of the five phases of the tennis serve: ready phase, grip phase, swing phase, contact phase, and follow through phase.

Questions were developed by the main investigator using the Interactive Tennis and Tennis Task Analysis CD-ROMs' content. Content validity of the test was determined by a group of experts using a Likert scale. Content validity of test was reported as 83.5 %-98.8 %. The validity of the content knowledge test was determined by the percentage of agreement across the experts by item. The experts were:

1- Dr. Elizabeth Petrakis: Emeritus Professor of University of Nebraska Lincoln (UNL), Department of Health and Human Performance. Dr. Petrakis has taught 33 years at UNL including motor learning and tennis courses. In addition, she coached women tennis team for 4 years at UNL.

2- Mr. Jay Vasil: He is currently second year Ph. D Student and candidate at Pennsylvania State University in the Department of Kinesiology. Mr. Vasil had three years teaching experience as a physical educator. He has coached high school tennis at Lewisburg

Area in Pennsylvania where his team won both individual and team district championships. Jay has six years of private instruction experience and he is lifetime member of the USTA. He also has teaching experience in youth camps, and as an assistant instructor at Pennsylvania State University.

3-Mr. Stephen Yang: He is currently second year Ph. D. student and candidate at Pennsylvania State University in the Department of Kinesiology. Mr. Yang taught high school physical education for four and half years. He taught tennis in PE 12 Leadership and Recreation class over three years. Stephen has experienced two terms of teaching collegiate basic instruction courses in swimming, weight training and tennis at Virginia Tech. In addition, he has completed Canadian National Coaching Level III Theory and Technical Certification Program (NCCP).

The reliability coefficient of the knowledge test was reported by a Kuder-Richardson formula test of reliability. The Kuder-Richardson formula is considered to estimate the real lower reliability of a test. In this calculation, the mean of the scores, the number of items in the test was used, and the standard deviation of test scores squared (McGee, 2000). The reliability coefficient of the knowledge test was reported as .83 from the formula.

Tennis Serve Pedagogical Content Knowledge (PCK) Assessment Sheet

The second instrument was Tennis Serve Pedagogical Content Knowledge (PCK) Assessment Sheet. Pedagogical Content Knowledge (PCK) is a special amalgam of content and pedagogical knowledge. Teachers provide PCK by using metaphors, demonstrations, cues, and feedback (Shulman, 1987).

A pedagogical content knowledge assessment sheet was developed by the main investigator to measure PCK (Figure A). All participants taught two six-minute microteachings to Virginia Tech Basic Instruction Program tennis students about the tennis serve as a pre-test and post-test to determine PCK. Each participant was videotaped by a video camera, and the tapes were analyzed by the main investigator and a doctoral student using a PCK observation sheet. Reliability of data was determined by the interobserver agreement (IOA). At least 20% of videotapes were analyzed for IOA and 80% agreement was set as a criteria.

The interobserver agreement is defined as the extent that human observers agree in recording the occurrence and non-occurrence of specific behaviors. It also consists of judging the

reliability of the agreement between data collected on specific target behaviors by two different observers (Cooper, Heron, & Heward, 1987). It is very essential to determine the believability of data. The higher the interobserver agreement, the more confidence can be placed on the accuracy of the data.

In the study, the interobserver agreement was determined by the occurrence and nonoccurrence of specific behaviors in microteachings such as feedback, demonstrations, and cues. This was determined by using a formula of interobserver agreement. This formula was calculated by determining the total number of agreements and dividing that number by the total number of agreement plus disagreements. Then multiply that number by 100 to achieve a percentage. The formula is as follows:

$$\frac{\text{Agreements}}{\text{Agreements} + \text{Disagreements}} \times 100 = \text{Percentage of agreement}$$

An eighty-percent IOA criteria was set before analyzing the videotapes. Interobserver agreement was reported as 82 %-95 % in present study. Appendix B shows the criteria and procedures for analysis of video tapes and interobserver agreement.

Tennis Serve Skill Analysis Test

The third instrument was Tennis Serve Skill Analysis Test. Skill analysis competency can be defined as the teachers' ability to analyze and correct the errors in a skill performance of students. The most common way of this is qualitative analysis of movement that has been defined as observing a movement or skill and deciding how closely the specific features and sequence patterns of the performance adhere to accepted standards for that specific skill (Morrison & Reeve, 1988).

Subjects were tested by a videotape developed by the main investigator. The main investigator developed this videotape using a digital camera according to the content of the multimedia CD-ROMs used in the CAI group. Nearly one hundred movie segments were recorded for the twelve main segments. After editing in a multimedia instructional technology lab at Virginia Tech, only thirty-six of the original items were used in twelve segments used for the videotape and paper and pencil test content (Appendix D). The videotape is six minutes long. A small group of students completed the exam together. Each subject was asked to observe the

movement patterns in each of the film segments and they checked on a paper and pencil test if the desired skill is observed or not. Each subject was allowed to observe the videotape two times in their groups to catch missed questions and review.

The content validity of the video and paper and pencil skill test was determined by a group of experts using a Likert scale. Content validity of skill test was reported as 78.8 %-95.5 %. The validity of the skill test was determined by the percentage of agreement across the experts by item. The reliability coefficient of the skill test was reported by the Split-Half method. In this method, a test is split into halves and the scores of the two halves are correlated. This method requires only one administration of the test and does not require construction of a second test (Miller, 2002). The test has a maximum score of 36 points. The reliability coefficient of the tennis serve skill analysis test was .64.

Tennis Task Sequence Test

The last instrument is Tennis Task Sequence Test. Task sequence is a practical order of teaching a skill that determines the content and organizational aspects of the task. A teacher follows these teaching patterns when she/he teaches skills in a sequential order. The task sequence provides information about what task is to be performed and the organizational arrangements of the tasks to be performed (Rink, 2002).

The main investigator developed the tennis task sequence test (Appendix E) using the content of the Interactive Tennis and Tennis Task Analysis CD-ROMs. Tennis task sequence test was administered as a paper and pencil pre-test and post-test. The content validity of the paper and pencil task sequence test was determined by a group of experts using a Likert scale. Content validity of test was reported as 88 %-96.8 %. The validity of the task sequence test was determined by the percentage of agreement across the experts by item. The reliability coefficient of the task sequence test was reported by the test retest method. The test has a maximum score of 40 points. The reliability coefficient of task sequence test was .72.

Students' Attitudes Toward CAI

The attitudes of PETE majors toward CAI were determined via three open-ended short-answer questions (Wilkinson et al., 2000) from only the CAI group in the study. These questions

were evaluated using a qualitative analysis method. The following questions were used to determine students' attitudes toward CAI:

- 1- What did you like about using the multimedia tennis CD-ROMs?
- 2- What didn't you like about using the tennis CD-ROMs?
- 3- Would you like to use other CD-ROMs in your PETE method courses?

Experimental Design

The experimental design of this study was three groups with repeated measures: Computer-Assisted Instruction (CAI) and Teacher Instruction (TI), and Control Group (CG) with a pre-test and a post-test. This procedure involved the random assignments of subjects into groups. Pre-tests and post-tests administered to all groups, but treatments were administered to only the experimental groups (CAI and TI). One of the important characteristics of the experimental design is the specific use of independent variables. Some experiments involve between-subjects design wherein different individuals are assigned to treatment groups (Creswell, 1994; Rosenthal & Rosnow, 1991).

Pilot Study

A pilot study was conducted in Fall 2002 semester at a regional university by the main investigator to determine reliability and validity of test instruments. The subjects for pilot study were selected from an undergraduate physical education program. 15 students enrolled in an introduction course were given the opportunity to participate and randomly stratified by gender and then assigned to three groups. Students received 50 minutes CAI and Teacher Instruction as interventions, completed all tests and taught two six minute microteaching sessions as pre and post test measurements. The results of this pilot study revealed that both the CAI and Teacher instruction groups performed significantly better than the control group on the dependent variables. In addition, tests were reported reliable and valid. Content validity of skill test was reported as 78.8 %-95.5 % by a group of expert and the reliability coefficient of the tennis serve skill analysis test was .66. Content validity of task sequence test was reported as 88 %-96.8 % by group of expert and the reliability coefficient of task sequence test was .76.

Statistical Design

The results of the study were analyzed with nonparametric tests. Only the students' perceptions toward CAI were analyzed via qualitative methods. The main investigator used Kruskal-Wallis test to determine the differences between the groups. In addition, if there were difference among the groups, using Mann-Whitney U test Pairwise rankings were conducted to determine the difference between all comparisons as a post hoc analysis. Wilcoxon Signed Rank test was utilized to examine pre-test to post-test changes within the groups (Cicciarella, 1997; Green et al., 2000). Alpha set at $p < 0.5$.

CHAPTER 4

RESULTS

The purpose of this study was to determine the effects of multimedia CAI on undergraduate PETE majors' teaching of the serve in tennis. This chapter provides quantitative and qualitative results about the effects of multimedia CAI and teacher instruction as interventions. There are five dependent variables: PETE majors' tennis serve Content Knowledge (CK); PETE majors' tennis serve observation skills or skill analysis (SA); PETE majors' tennis serve Task Sequence (TS); PETE majors' use of Pedagogical Content Knowledge (PCK) and PETE majors' perception toward CAI.

The data were obtained from 18 undergraduate students enrolled in a PETE evaluation and assessment course at Virginia Tech. Subjects were stratified by gender and randomly assigned to three groups as Computer-Assisted Instruction (CAI) group (n=6), Teacher Instruction (TI) group (n=6), and Control (CG) group (n=6). The results of this study were gathered from three tests: Tennis Serve Content Knowledge Test, Tennis Serve Skill Analysis Test, Tennis Task Sequence Test. In addition, two six minute micro teaching sessions were conducted and data was collected via the Tennis Serve Pedagogical Content Knowledge (PCK) Assessment Sheet, and finally, an open ended survey was completed to understand students' attitudes toward CAI.

There are two independent variables in this study. These are instructional methodology (CAI, TI, CG) and time (pre-test, post-test). The results of the study were analyzed with nonparametric tests. The Kruskal-Wallis test was used to determine the differences among the three groups, and pairwise ranking with the Mann Whitney U test was conducted between all comparisons as a post hoc analysis. Moreover, the Wilcoxon Signed Rank test was used to determine pre-to post-test changes within the groups. Alpha set at $p < 0.5$.

Tennis Serve Content Knowledge Test

The first research question was about the effects of multimedia CAI on PETE majors' tennis serve content knowledge. This was measured via a 17-item multiple-choice paper and pencil VTPE Tennis Serve Content Knowledge pre-and post-test. The pre-test mean for the TI group was 7.5, the CAI group 7 and the CG 8.16. The post-test mean for the TI group was 13

with a gain of 5.50. The post-test mean for the CAI group was 11.3 with a gain of 4.33 and the post-test mean for the CG was 9.33 with a gain of 1.17. Results showed that the gain from pre-test to post-test was evident for the TI and CAI groups. However, the CG group did not gain much at all. Table 1 and 2 displays descriptive statistics about the tennis serve content knowledge tests for groups respectively in Appendix A.

Table 3 displays information about the comparison of tennis serve content knowledge. The Kruskal-Wallis test indicated that there were significant differences among the three groups, $\chi^2(2, N=18) = 9.93, p = .007$. Because the overall test was significant, pairwise comparisons among the three groups were conducted.

Table 3

Comparison of Tennis Serve Content Knowledge Test Scores Among the Groups

Group	N	Mean Rank	DF	P Value
TI	6	13.25	2	.007*
CAI	6	11.17		
CG	6	4.08		

* Significant at the .05 level.

Table 4 displays information about pairwise comparison between the TI and CAI groups.

Table 4

Pairwise Comparison of Tennis Serve Content Knowledge Test Scores Between TI and CAI

Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	7.25	43.50	.459
CAI	6	5.25	34.50	

Note: Not significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison showed that there were no significant differences between the TI and CAI groups in tennis serve content knowledge, $z = .740$, $p = .459$.

Table 5 displays information about pairwise comparison between the CAI and CG groups in tennis serve content knowledge.

Table 5

Pairwise Comparison of Tennis Serve Content Knowledge Test Scores Between CAI and CG

Groups

Group	N	Mean Rank	Sum of Ranks	P Value
CAI	6	8.92	53.50	.019*
CG	6	4.08	24.50	

* Significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison indicated that there were significant differences between the CAI and CG groups with the CAI group performing significantly better in tennis serve content knowledge test, $z = -2.355$, $p = .019$.

Table 6 displays information about pairwise comparison of tennis serve content knowledge between the TI and CG groups.

Table 6

Pairwise Comparison of Tennis Serve Content Knowledge Test Scores Between TI and CG

Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	9.50	57.00	.004*
CG	6	3.50	21.00	

* Significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison indicated that there were significant differences between the TI and CG groups with the TI group performing significantly better in tennis serve content knowledge test, $z = -2.913$, $p = .004$.

A Wilcoxon sign rank test was conducted to understand the differences within the groups. Results indicated that TI group improved significantly within the group from pre to post-test, $z = -2.041$, $p = .041$., the CAI group did not improve significantly within the group from pre to post-test, $z = -1.890$, $p = .059$. and the CG group did not improve significantly within the group from pre to post-test, $z = -.816$, $p = .414$.

Overall, there are differences among the groups in tennis serve content knowledge test, and results showed that both the TI and CAI groups performed significantly better than the CG group in the knowledge test. In addition, only the TI group improved significantly within the group from pre to post-test. The control group did not improve at all.

Tennis Serve Pedagogical Content Knowledge (PCK)

The second research question was about the effects of multimedia CAI on PETE majors' tennis serve pedagogical content knowledge (PCK). PCK is a special amalgam of content and pedagogical knowledge. Teachers provide PCK by using metaphors, demonstrations, cues, and feedback (Shulman, 1987). This was measured by a microteaching lesson via a videotape and recorded on a VTPE pedagogical content knowledge observation sheet.

PCK-Appropriate Cues

Table 7 and 8 in display descriptive statistics about tennis serve PCK in appropriate cues for groups respectively in Appendix A. The pre-test mean for the TI group was .50, the CAI group .83 and the CG .50. The post-test mean for the TI group was 6.5 with a gain of 6.00. The post-test mean for the CAI group was 4.00 with a gain of 3.17, and the post-test mean for the CG was 1.33 with a gain of 0.17. Results showed that the gain from pre-test to post-test was evident for the TI and CAI groups. However, the CG did not gain much at all.

Table 9 displays information about the comparison of tennis PCK-Appropriate cues. The Kruskal-Wallis test indicated that there were significant differences among the three groups, $\chi^2(2, N=18) = 8.860, p = .012$. Because the overall test was significant, pairwise comparisons among the three groups were conducted.

Table 9

Comparison of Tennis Serve PCK-Appropriate Cues Scores Among the Groups

Group	N	Mean Rank	DF	P Value
TI	6	14.17	2	.012*
CAI	6	9.25		
CG	6	5.08		

* Significant at the .05 level.

Table 10 displays information about pairwise comparison between the TI and CAI groups.

Table 10

Pairwise Comparison of Tennis Serve PCK-Appropriate Cues Scores Between TI and CAI

Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	8.17	49.00	.104
CAI	6	4.83	29.00	

Note: Not significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison showed that there were no significant differences between the TI and CAI groups in tennis serve PCK-Appropriate cues, $z = -1.624$, $p = .104$.

Table 11 displays information about pairwise comparison between the CAI and CG groups in tennis serve content knowledge.

Table 11

Pairwise Comparison of Tennis Serve PCK-Appropriate Cues Scores Between CAI and CG

Groups

Group	N	Mean Rank	Sum of Ranks	P Value
CAI	6	7.92	47.50	.167
CG	6	5.08	30.50	

Note: Not Significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison indicated that there were no significant differences between the CAI and CG groups in tennis serve PCK-Appropriate cues test, $z = -1.383$, $p = .167$.

Table 12 displays information about pairwise comparison of tennis serve PCK-Appropriate cues between the TI and CG groups.

Table 12

Pairwise Comparison of Tennis Serve PCK-Appropriate Cues Scores Between TI and CG

Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	9.50	57.00	.004*
CG	6	3.50	21.00	

* Significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison indicated that there were significant differences between the TI and CG groups with the TI group performing significantly better in tennis serve PCK-Appropriate cues test, $z = -2.918$, $p = .004$.

A Wilcoxon sign rank test was conducted to understand the differences within the groups. Results indicated that the TI group improved significantly within the group from pre to post-test, $z = -2.214$, $p = .027$, the CAI group did not improve significantly within the group from pre to post-test, $z = -1.892$, $p = .058$ and the CG group did not improve significantly within the group from pre to post-test, $z = -1.633$, $p = .102$.

Overall, there are differences among groups in tennis serve PCK-Appropriate cues test and results showed that the TI group performed significantly better than the CAI and CG groups. In addition, only the TI group improved significantly within the group from pre to post-test. The CAI and CG groups did not improve at all.

PCK-Appropriate Feedback

Table 13 and 14 display the descriptive statistics in Appendix A about tennis serve PCK in appropriate feedback for groups respectively. The pre-test mean for the TI group was .16, the CAI group .33 and the CG .00. The post-test mean for the TI group was 0.50 with a gain of .34. The post-test mean for CAI group was .33 with a gain of .00, and the post-test mean for the CG was .00 with a gain of .00. Results showed that the gain from pre-test to post-test was not evident for any of the groups.

Table 15 displays information about the comparison of tennis PCK-Appropriate feedback. The Kruskal-Wallis test indicated that there were no significant differences among the three groups, $\chi^2(2, N=18) = 2.022, p = .364$. Because the overall test was not significant, pairwise comparisons among the three groups did not conduct as a post hoc analysis.

Table 15

Comparison of Tennis Serve PCK-Appropriate Feedback Scores Among the Groups

Group	N	Mean Rank	DF	P Value
TI	6	11.33	2	.364
CAI	6	8.67		
CG	6	8.50		

Note: Not significant at the .05 level.

A Wilcoxon sign rank test was conducted to understand the differences within the groups and results indicated that the TI group did not improve significantly within the group from pre to post-test, $z = -1.414, p = .157$, the CAI group did not improve significantly within the group from pre to post-test, $z = .00, p = 1.00$ and the CG group did not improve significantly within the group from pre to post-test, $z = .00, p = 1.00$

Overall, there are not any differences among groups in the tennis serve PCK-Appropriate feedback test, and results showed that none of the groups improved significantly within the group from pre to post-test.

PCK-Appropriate Demonstration

Table 16 and 17 display descriptive statistics about tennis serve PCK in appropriate cues for groups respectively in Appendix A. The pre-test mean for the TI group was .50, the CAI group .83 and CG .50. The post-test mean for the TI group was 5.33 with a gain of 4.83. The post-test mean for the CAI group was 3.83 with a gain of 3.00, and the post-test mean for the CG was .66 with a gain of 0.16. Results showed that the gain from pre-test to post-test was evident for the TI and CAI groups. However, the CG did not gain much at all.

Table 18 displays information about the comparison of tennis PCK-Appropriate demonstration. The Kruskal-Wallis test indicated that there were significant differences among the three groups, $\chi^2(2, N=18)=11.047, p = .004$. Because the overall test was significant, pairwise comparisons among the three groups were conducted.

Table 18

Comparison of Tennis Serve PCK-Appropriate Demonstration Scores Among the Groups

Group	N	Mean Rank	DF	P Value
TI	6	14.00	2	.004*
CAI	6	10.50		
CG	6	4.00		

* Significant at the .05 level.

Table 19 displays information about pairwise comparison between the TI and CAI groups.

Table 19

Pairwise Comparison of Tennis Serve PCK-Appropriate Demonstration Scores Between TI and CAI Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	8.08	48.50	.125
CAI	6	4.92	29.50	

Note: Not significant at the .05 level

A Mann-Whitney U test was conducted. Pairwise comparison showed that there were no significant differences between the TI and CAI groups in tennis serve PCK-Appropriate demonstration, $z = -1.535$, $p = .125$.

Table 20 displays information about pairwise comparison between the CAI and CG groups in tennis serve PCK-Appropriate demonstration.

Table 20

Pairwise comparison of Tennis Serve PCK-Appropriate Demonstration Scores Between CAI and CG Groups

Group	N	Mean Rank	Sum of Ranks	P Value
CAI	6	9.08	54.50	.011*
CG	6	3.92	23.50	

*Significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison indicated that there were significant differences between the CAI and CG groups in tennis serve PCK-Appropriate demonstration test, $z = -2.536$, $p = .011$.

Table 21 displays information about pairwise comparison of tennis serve PCK-Appropriate demonstration between the TI and CG groups.

Table 21

Pairwise Comparison of Tennis Serve PCK-Appropriate Demonstration Scores Between TI and CG Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	9.42	56.50	.004*
CG	6	3.58	21.50	

* Significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison indicated that there were significant differences between the TI and CG groups with the TI group performing significantly better in tennis serve PCK-Appropriate demonstration test, $z = -2.863$, $p = .004$.

A Wilcoxon sign rank test was conducted to determine the differences within the groups and results indicated that the TI group improved significantly within the group from pre to post-test, $z = -2.207$, $p = .027$, the CAI group improved significantly within the group from pre to post-test, $z = -2.207$, $p = .027$ and the CG group did not improve significantly within the group from pre to post-test, $z = -.447$, $p = .655$.

Overall, there are differences among groups in tennis serve PCK-Appropriate demonstration test and results showed that the TI and CAI groups performed significantly better than CG group. In addition, both the TI and CAI groups improved significantly within the group from pre to post-test. The CG group did not improve at all.

PCK-Inappropriate Cues, Feedback and Demonstration

After the data collection and analysis, results showed that students had very limited numbers of inappropriate cues, feedback and demonstration during six minutes micro teaching sessions and results were not statistically significant. Therefore, the results of PCK-Inappropriate cues, feedback and demonstrations were not included in this chapter.

Tennis Serve Skill Analysis Test

The third research question was about the effects of multimedia CAI on PETE majors' tennis serve skill analysis. This was measured by via a 36-item paper and pencil VTPE Tennis Serve Skill Analysis pre-and post-tests, and by observing a skill analysis videotape. Table 22 and 23 display descriptive statistics about tennis serve skill analysis test for groups respectively in Appendix A. The pre-test mean for the TI group was 25.83, the CAI group 22.33 and the CG 17.66. The post-test mean for the TI group was 27.16 with a gain of 1.33. The post-test mean for the CAI group was 27.50 with a gain of 5.17, and the post-test mean for the CG was 18.66 with a gain of 1.00. Results showed that the gain from pre-test to post-test was evident for the CAI group. However, the TI and CG groups did not gain much at all.

Table 24 displays information about the comparison of tennis serve skill analysis. The Kruskal-Wallis test indicated that there were no significant differences among the three groups, $\chi^2(2, N=18) = 2.95, p = .229$. Because the overall test was not significant, pairwise comparisons among the three groups did not conduct as a post hoc analysis. In general, results showed that the CAI and Teacher Instruction interventions did not have any effect for skill analysis on groups.

Table 24

Comparison of Tennis Serve Skill Analysis Test Scores Among the Groups

Group	N	Mean Rank	DF	P Value
TI	6	8.42	2	.229
CAI	6	12.50		
CG	6	7.58		

Note: Not significant at the .05 level.

A Wilcoxon sign rank test was conducted to determine the differences within the groups and results indicated that the TI group did not improve significantly within the group from pre to post-test, $z = -1.134$, $p = .257$, the CAI group did not improve significantly within the group from pre to post-test, $z = -1.782$, $p = .075$ and the CG group did not improved significantly within the group from pre to post-test, $z = -1.890$, $p = .059$. Overall, there were no differences among groups in tennis serve skill analysis test. In addition, none of the groups improved significantly within the group from pre to post-test.

In general, results showed that there were no significant differences among the groups in tennis serve skill analysis. Therefore, post hoc analysis did not conduct. In addition, none of the groups improved significantly within the group from pre to post-test.

Tennis Serve Task Sequence Test

The fourth research question was about the effects of multimedia CAI on PETE majors' tennis task sequence. This was measured via the paper and pencil VTPE Tennis Serve Task Sequence pre-and post-tests. Table 25 and 26 display descriptive statistics about tennis serve task sequence test for groups respectively in Appendix A. The pre-test mean for the TI group was 4.00, the CAI group 5.00 and CG 4.83. The post-test mean for the TI group was 25.00 with a gain of 21.00. The post-test mean for the CAI group was 13.16 with a gain of 8.16, and the post-test mean for the CG was 9.00 with a gain of 4.17. Results showed that the gain from pre-test to

post-test was evident for the TI and CAI groups. However, the CG group did not gain much at all.

Table 27 displays information about the comparison of the tennis serve task sequence test. The Kruskal-Wallis test indicated that there were significant differences among the three groups, $\chi^2(2, N=18) = 9.637, p = .008$. Because the overall test was significant, pairwise comparisons among the three groups were conducted.

Table 27

Comparison of Tennis Serve Task Sequence Test Scores Among the Groups

Group	N	Mean Rank	DF	P Value
TI	6	14.92	2	.008*
CAI	6	7.67		
CG	6	5.92		

* Significant at the .05 level.

Table 28 displays information about pairwise comparison between the TI and CAI groups.

Table 28

Pairwise Comparison of Tennis Task Sequence Test Scores Between TI and CAI Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	8.92	53.50	.020*
CAI	6	4.08	24.50	

*Significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison showed that there were significant differences between the TI and CAI groups in tennis serve task sequence, $z = -2.334$, $p = .020$. The TI group performed significantly better than the CAI group.

Table 29 displays information about pairwise comparisons between the CAI and CG groups in tennis serve content knowledge.

Table 29

Pairwise Comparison of Tennis Serve Content Task Sequence Test Scores Between CAI and CG

Groups

Group	N	Mean Rank	Sum of Ranks	P Value
CAI	6	7.08	42.50	.573
CG	6	5.92	35.50	

Note: Not significant at the .05 level.

A Mann-Whitney U test was conducted. Pairwise comparison indicated that there were no significant differences between the CAI and CG groups in tennis serve task sequence test, $z = -.563$, $p = .573$.

Table 30 displays information about pairwise comparison of tennis serve task sequence between the TI and CG groups.

Table 30

Pairwise Comparison of Tennis Serve Task Sequence Scores Between TI and CG Groups

Group	N	Mean Rank	Sum of Ranks	P Value
TI	6	9.50	57.00	.004*
CG	6	3.50	21.00	

* Significant at the .05 level.

A Mann-Whitney U test was conducted to determine the differences within the groups. Pairwise comparison indicated that there were significant differences between the TI and CG groups. The TI group performed significantly better in tennis serve task sequence test, $z = -2.892$, $p = .004$. The TI group improved significantly within the group from pre to post-test, $z = -2.207$, $p = .027$, the CAI group did not improve significantly within the group from pre to post-test, $z = -1.802$, $p = .072$ and the CG group improved significantly within the group from pre to post-test, $z = -2.207$, $p = .027$.

In general, there are differences among groups in the tennis serve task sequence test, and results showed that the TI group performed significantly better than the CAI and CG groups. In addition, the TI and CG groups improved significantly within the groups from pre to post-test. The CAI group did not improve at all.

Perceptions of PETE Majors Toward Using CAI

The fifth question was about perceptions of PETE majors toward using CAI. Only the CAI group ($n = 6$) completed a survey including three open ended short questions. The first question was, "What did you like about using the multimedia tennis CD-ROMs?" Answers were positive in general. Students stated that it was very easy to follow, clear and informative. The most common student comment was about the task sequences in the CD-ROMs. For example, students said that, "They were very informative and break down each step in the sequence of the

serve”, and, “It helped break down the serve into smaller parts.” Only one student’s comment was negative and stated as, “It was boring and repetitive.”

The second question was, “What didn’t you like about using the tennis CD-ROMs?” The general problems were stated as long, repetitive and technical problems such as, “I didn’t like that it was hard to see the guy giving the demonstrations”, or another student wrote that, “ I was not able to ask questions. I had a few computer problems too.” In addition, one of the students reported that, “ During one of the tests I had gotten 5 out of 5 but it said I had 4 out of 5.” Only one student stated very negative comment like “ Everything. I didn’t like how we had to teach ourselves.”

The third question was “ Would you like to use other CD-ROMs in your PETE method courses?” Students’ comments were positive about this question. They stated that CDs were very helpful and a good way to learn. One student stated that, “ Yes, I learned from it and it was fun putting the separate parts together to form the sequence.”

In brief, students liked to use CD-ROMs, and they showed positive attitudes toward CAI. They favored how the CDs were divided into task sequences and parts to teach in a systematic way. It is obvious that some of the students had computer problems during application, and also being repetitive because of the nature of the CAI itself was the most prominent complaint.

CHAPTER 5

DISCUSSION

The main purpose of this study was to determine the effects of multimedia Computer Assisted Instruction (CAI) on undergraduate PETE majors teaching of the serve in tennis. This chapter provides information about the discussion of the results, conclusions and future suggestions. 18 undergraduate PETE students participated as subjects at Virginia Tech. The findings in this study are based on (a) tennis serve content knowledge; (b) tennis serve Pedagogical Content Knowledge (PCK); (c) tennis serve skill analysis; (d) tennis serve task sequence; and (e) PETE majors' perceptions toward CAI. Teacher Instruction (TI) and Computer Assisted Instruction (CAI) were used as independent variables.

Summary of the Results

Analysis of data provided following major results in the study:

1. Significant differences were found among the groups in tennis serve content knowledge test. Post hoc analysis showed that the TI and CAI groups performed significantly better than the CG group. However, no significant differences were found between the TI and CAI groups. In addition, only the TI group improved significantly within the group pre to post-test.
2. Significant differences were found among the groups in tennis serve PCK-Appropriate cues. Post hoc analysis revealed that the TI group performed significantly better than the CAI and CG groups. Only the TI group improved significantly within the group pre to post-test and the CAI and CG groups did not improve within the group.
3. No significant differences were found among the groups in tennis serve PCK-Appropriate feedback. Therefore, post hoc analysis did not used. Besides, none of the groups improved within the group from pre to post-test.
4. Significant differences were found among groups in tennis serve PCK-Appropriate demonstration. Post hoc analysis showed that there were no significant differences between the TI and CAI groups. However, both the TI and CAI groups performed significantly better than those in the CG group. Moreover, both the TI and CAI groups improved significantly within the group pre to post test. The CG group did not improve at all.

5. Results indicated that students had very limited numbers of Inappropriate-Cues, Feedback, and demonstration. There was no statistically significant data.
6. No significant differences were found among the groups in tennis serve skill analysis. Therefore, post hoc analysis was not used. In addition, none of the groups developed within the group from pre to post-test in tennis serve skill analysis.
7. Significant differences were found among the groups in tennis serve task analysis. Results indicated that the TI group performed significantly better than the CAI and CG groups. In addition, the TI and CG groups improved significantly within the group from pre to post test. The CAI group did not improve at all.
8. Students' perceptions toward CAI were positive in general. Students in the CAI group indicated that they liked using CAI as an instructional method, and that the sequential approach was very helpful to learn.
9. However, some of the students indicated that CAI was very repetitive and boring. In addition, several technical problems were reported.
10. The majority of the students reported that they would like to use CAI in other PETE method courses as a way of instruction. Only one student indicated negative comment about this.

Tennis Serve Content Knowledge

Content knowledge can be defined as a form or procedure that deals with the subject matter to be taught in a specific area (Perez & Saury, 1999). One of the questions in this study was about the effect of CAI on the students' tennis serve content knowledge. The results of this study revealed that both the TI and CAI groups performed significantly better than the Control group. However, no significant differences were found between the CAI and TI groups, and only the TI group improved significantly within the group.

Literature review should be analyzed very carefully to understand the effects of CAI, and this review produced mixed results about the effects of CAI on content knowledge or students' subject matter achievement. It can be concluded that literature did not favor CAI versus other teaching methods in many cases.

Kulik et al., (1980) reviewed fifty-nine research studies and found that CAI made a small but significant contribution to the achievement of college students in different subject matters. In

another study, Christmann et al., (1997) used meta-analysis to examine the effects of CAI on the academic achievement of secondary students in different subject matters versus traditional teaching methods and traditional teaching methods supplemented with CAI. They found that students who received traditional instruction supported with CAI gained significant scores than those taught with traditional methods. Moreover, Perzylo and Oliver (1992) found that CAI improved elementary school children' subject matter knowledge in geography more than traditional methods. In contrast, Shute and Miksad (1997) found mixed results. They examined the effects of CAI on cognitive development for verbal, language and math skills in preschoolers during an eight-week period. Results showed that CAI increased student achievement in verbal and language skills but not in math. However, Ross, et al., (1991) found that CAI increased student achievement in math and reading for seventh grade students at risk. Overall, these findings produced mixed results about the effectiveness of CAI on different subject matters and content knowledge.

Parallel to findings above, CAI literature in Physical Education, PETE and Kinesiology courses produced mixed results about the effects of CAI on content knowledge. In physical education there are only three studies that assessed the effectiveness of CAI. Wilkinson et al., (1999) examined the effects of CAI on cognitive and psychomotor skills of junior high school girls. Results showed that both the CAI and the teacher instruction groups improved significantly in volleyball content knowledge but there was no significant difference between groups. Similar to findings in Wilkinson's study, Skinsley and Brodie (1992) found the same results in content knowledge. They assessed the effectiveness of CAI on the cognitive knowledge of 12 year old male students' badminton knowledge and results showed that both the CAI and the teacher instruction group improved but there was no significant difference between the two groups. The only research at the elementary school level was conducted by Alvarez-Ponss in 1992. He assessed the effects of CAI in teaching tennis rules, scoring and terminology to fifth grade students. The results showed that there was no significant difference between groups but both groups improved their scores from pre to post-test.

Research in PETE and Kinesiology courses also produced mixed results about the effects of CAI on content knowledge. To date there are only five research studies about the effects of

CAI in PETE courses. These are two elementary method courses (McKethan et al., 2000; McKethan et al., 2001), one statistics course (Whitaker, 1990), one exercise physiology course (Adams et al., 1989), and one undergraduate Kinesiology course (Lease, 1981). McKethan et al., (2000) examined the effects of CAI on learning and teaching cues of manipulative skills on preservice elementary education majors. Results indicated that although the teacher instruction group scored significantly higher than the CAI group on post-test, there were no significant differences between the groups. Another study, McKethan et al., (2001) replicated the same study of preservice physical education majors and results showed that although the multimedia and teacher instruction groups performed significantly better than the control group there were no significant differences between the groups. Whitaker (1990) conducted a study to compare different instructional strategies on physical education majors' knowledge of statistics. This study did not find any differences among CAI, tutor retrieval text, and programmed learning groups. In a different perspective, Adams et al., (1989) compared mandatory CAI versus voluntary CAI in an undergraduate exercise physiology course for PETE majors. Results showed that the mandatory CAI group performed significantly better than the voluntary group. On the contrary, Lease (1981) found that CAI had a positive effect on PETE majors' knowledge of the mechanical analysis of motion as one of the early interventions in the field.

Overall, findings in this study produced very similar results compared to the literature reviewed above in content knowledge. Results indicated that both the CAI and TI groups performed significantly better than the control group in tennis serve content knowledge test, but no significant differences were found between the CAI and TI groups. In general, it can be concluded that the literature review did not favor CAI over traditional instruction or different modes of instruction for development of content knowledge in many cases. However, CAI interventions provided a decent progress in content knowledge and this should not be ignored in many cases.

At this point, we should be very careful about the analysis of the results of CAI interventions because literature review shows that CAI research was conducted in different subject matters, interventions, duration and populations ranging from preschool to college. The most important consideration should be about the quality of time spent with CAI because longer

and effective interventions may have a key role here. Meta-analytic research of Khali and Shashani (1994) supported this notion. They examined thirty-six studies and found that although CAI increased student achievement in subject matters, they concluded that the most effective duration time was four to seven weeks, and the effect of CAI disappeared when it used for less than three weeks. Moreover, researchers indicated that older students got more benefit from CAI compared to younger ones. The level of cognition can explain this, but there is no research about this until now.

It is very interesting that research produced positive results about CAI when it was applied in combination with teacher instruction or traditional modes of instruction. This conclusion was proved by Christmann et al., (1997). They conducted a meta-analytic technique in twenty-six studies to compare the effects of CAI on the academic achievement of secondary students in different subject matters, versus traditional teaching methods and traditional teaching methods supplemented with CAI. Results showed that students who received traditional instruction supplemented with CAI gained significantly scores in subject matter than those taught with only with traditional teaching methods. In a broader perspective, this is very logical because every instructional strategy may have advantages and disadvantages, so having a combination of different teaching strategies may promote effective learning outcomes because of the dynamic and complex characteristics of a teaching and learning environment.

Another important point is about the method of assessment in content knowledge. It seems that the majority of studies reviewed in the literature used very traditional ways of assessment, including present study, such a paper and pencil test. Therefore, nontraditional or authentic way of assessment of content should be used in future studies. As an exemplary research, Perzylo and Oliver (1992) conducted a study to investigate the use of CAI in the classes of 32 elementary school children. The National Geographic Society Mammals Multimedia was used as an intervention during the four-weeks. Researchers used field notes, students' summary papers, and interviews for gathering data. This non-traditional multi-assessment method may be a good alternative for future studies in CAI to assess content or specific subject matter knowledge.

In summary, parallel to existing literature, the present study found both the CAI and TI groups performed significantly better than the control group, but there was no difference between the CAI and TI groups in tennis serve content knowledge. It can be concluded that CAI can still be used as a mode of instruction to provide subject specific content knowledge in teaching and learning environment, if considering the duration, method of delivery and cognition of subjects.

Tennis Serve Pedagogical Content Knowledge (PCK)

Pedagogical content knowledge was defined by Shulman (1987) as, “the special amalgam of content and pedagogy that is uniquely the province of teachers, their special form of professional understanding. ” In this knowledge, teachers provide PCK by using metaphors, demonstrations, cues and feedback. In the present study, students performed two six-minute microteaching units and were videotaped as a part of pre and post-test.

One of the questions in this study was about the effects of CAI on students’ PCK in tennis serve. The results of this study indicated three important results. The first, significant differences were found among the groups in appropriate cues. The TI group performed significantly than in the CAI and Control groups, and only the TI group improved significantly within the group. The second, no significant differences were found among the groups in appropriate feedback and none of the groups improved. The third, significant differences were found among the groups in appropriate demonstration, and both the TI and CAI groups performed significantly better than in the Control Group. In addition, only the TI and CAI groups improved significantly within the group. In brief, results showed that CAI was only effective on PCK-Appropriate demonstration and the TI group performed significantly better in PCK-Appropriate cues and demonstration.

Although early research on teacher education programs emphasized the importance of subject matter knowledge or content knowledge, the first definition of Pedagogical Content Knowledge or PCK in education and teacher education was provided by Shulman and his colleagues at Stanford University. During the last two decades, there has been increasing research in teachers’ PCK in English (Grossman, 1988), social studies (Gudmundsdottir & Shulman, 1987), mathematics, (Carpenter et al., 1988; Marks, 1990) and science education (van Driel et al., 1998).

At the same time, PCK in physical education and PETE has become an emerging research trend in the last decade. The first research studies in PETE focused on teacher cognition and decision, comparing expert teachers versus novice teachers (Griffey & Housner, 1991; Housner & Griffey, 1985; Housner, Gomez & Griffey, 1993a, 1993b). Later, this research trend was followed by acquisition, elaboration, and transformation of PCK by teachers focusing on categories of declarative and procedural knowledge (Dodds, 1994; Rink et al., 1994; Rovegno, 1992, 1993, 1994). Furthermore, several studies of PCK emphasized the role of university curriculum on PETE majors (Fernandez-Balboa et al., 1996; Griffin et al., 1996; O'Sullivan & Doutis, 1994; Metzler et al., 2000; Schempp, 1993).

This literature review shows that actually PCK is a very broad concept and can be analyzed in different perspectives. One of the new points in this study was the examination of PCK in terms of cues, feedback and demonstration with multimedia CD-ROMs intervention. This study was the first experimental study to determine the effects of CAI on PETE majors' PCK. The results of this study indicated that the TI group performed significantly better than the CAI and Control Groups in appropriate cues. There were no differences in appropriate feedback, and both the TI and CAI groups performed significantly better than the Control Group in appropriate demonstration.

This study showed that the TI group performed best in providing appropriate cues in tennis serve, and also the TI group improved significantly within the group. Thus, providing appropriate cues favored the teacher instruction method and not the CAI. McKethan et al., (2000) tested a multimedia computer program on elementary classroom teachers' content knowledge of manipulative skill cues with a paper and pencil test. Results favored the TI group over the CAI group. In another study, McKethan et al., (2001) replicated the same study on physical education majors, and they found that both the CAI and TI groups performed significantly better than the Control Group, but there were no differences between the CAI and TI groups. These results should be explained in caution because recent studies used very different ways of measuring cues. The present study used two six minute videotaped microteaching units in a teaching environment, and two other studies used a paper and pencil tests. In addition, the duration of interventions was different. Present study applied 60 minutes

CAI and Teacher Instruction to teach cues in tennis serve, and the other two studies used 10 minutes to teach skill cues in catching, kicking and throwing via CAI and Teacher instruction.

The present study found no differences between the groups and within the groups in terms of providing appropriate feedback. Interestingly, literature shows inconsistent results about providing feedback and student achievement in physical education (Sariscsany et al., 1995; Silverman & Tyson, 1994). However, the purpose of this study is not to determine the effects of feedback on student achievement. One of the disadvantages of this study was a limited amount of time to teach in a microteaching unit. Six minute was a very limited time and the majority of the PETE majors focused on cues and demonstration instead of giving feedback.

One of the significant results of this study was the appropriate demonstration in PCK. Results indicated that there were significant differences among groups in tennis serve PCK-Appropriate demonstration. Although there were no differences between the CAI and TI groups, both groups performed significantly than the Control Group and also both groups improved significantly within the group from pre to post tests. According to these results, it seems that the CAI intervention worked well only for PCK-Appropriate demonstration in the entire research. This could be related to multimedia and the visual formation of CD-ROMs, because each CD-ROM provided a very rich visual environment such as quick time movies, demonstration of photos, and task analysis of tennis serve skills in a tutorial way.

Briefly, this study was one of the first research applications about the effects of multimedia CD ROMs in PCK, especially in cues, feedback and demonstration. Limited micro teaching time could be one of the disadvantages of the study in terms of providing appropriate feedback. At this point, several recommendations can be made about future multimedia interventions for PCK. It seems that one shot experiments like this study do not provide deep information about the evolution of PCK in a broader base. Therefore, multiple microteaching units with longer teaching periods should be provided to subjects with different content matters. In addition, not only certain concepts like cues, feedback, and demonstration, but also other concepts such as content development, and management skills should be tested in future studies to understand different perspectives in PCK.

Tennis Serve Skill Analysis and Task Sequence

Skill analysis competency can be defined as the teacher's ability to analyze and correct the errors in the skill performance of students. One of the most common ways to do this is the qualitative analysis of movement, which has been defined as observing a movement and deciding how closely the specific features and sequence patterns of the performance adhere to accepted standards for that specific skill (Morrison & Reeve, 1988). On the other hand, task sequence is the practical order of teaching a skill that determines the content and organizational aspects of a task (Rink, 2002). Task sequence is an essential part of skill analysis because a teacher follows these teaching patterns when she/he teaches skills in a sequential order. Skill analysis is an important and vital capacity for every physical education teacher to have because physical education teachers must know the critical features of a skill or movement to provide immediate feedback. Skill analysis may lead to the early detection of errors, and corrective feedback can help for skill development.

Results of this study showed that there were no significant differences among the groups in tennis serve skill analysis. In addition, none of the groups developed within the group from pre to post-test in tennis serve skill analysis. Moreover, significant differences were found among the groups in tennis serve task analysis, and the TI group performed significantly better than the CAI and CG groups. Finally, the TI and CG groups improved significantly within the group from pre to post test. The CAI group did not improve at all.

This study used a qualitative analysis approach for skill analysis in tennis serve. Qualitative approach systematically observes the movement and makes judgment to provide appropriate feedback in order to improve performance (Knudson & Morrison, 1997). Although many research studies have shown the importance of qualitative skill analysis for physical education teachers, there is a limited application of qualitative skill analysis into PETE courses. On the other hand, the literature review shows that there are numerous research studies about the effects of qualitative skill analysis training on preservice and inservice physical education teachers, and classroom teachers.

Research on qualitative skill analysis has demonstrated that subjects who participate in special training for skill analysis performed significantly in the detection of errors compared to

other participants who do not have training (Armstrong & Hoffman, 1979; Morrison & Reeve, 1986; Morrison & Reeve, 1988; Satern et al., 1992). The results of this study indicated that none of the groups performed successfully in the qualitative skill analysis test. In addition, the TI group performed significantly better than CAI and CG groups in task analysis. The present study provided conflicting results compared to the literature review. However, it should be noted that this was one of the first studies of utilizing multimedia CD-ROMs in teaching skill and task analysis. Previous research studies used different methods of qualitative skill analysis training such as, written texts (Kernodle & McKethan, 2002), interactive videodisc (Walkley & Kelly, 1989), and videotape (Morrison & Reeve, 1986, 1988). Siedentop (1988) stated that completion of a kinesiology course in PETE curriculum does not affect skill analysis performance. It can be concluded that having just an hour of CAI or teacher instruction in a complex skill like tennis serve may not be enough to teach skill analysis for PETE majors. In addition, only teacher instruction worked very well to teach task analysis in tennis serve for PETE majors.

In conclusion, qualitative skill analysis should be an essential part of teacher training in physical education because early detection of errors by teachers, and immediate appropriate feedback can help students to develop motor skills. According to the literature review, there are different ways of training teachers in qualitative skill analysis. Knudson et al., (1991) stated that teachers and instructors can teach qualitative skill analysis with multiple methodologies. Kernodle and McKethan (2002) showed a good example of this. The authors compared four groups to determine the effects of a computer based distance-learning program on qualitative skill analysis of preservice physical education and elementary education majors. The groups were control, video intervention, text information, and a combination of video and text. The results indicated that the combination group was the most effective treatment. In brief, using multiple methodologies in skill analysis could be an alternative way of providing different interventions for future studies because teaching and learning is a dynamic and complex environment, and each individual may have different learning strategies and styles. Therefore multiple interventions should be the focus of future research studies in qualitative skill and task analysis research in PETE.

Perceptions of Students Toward CAI

Students' perception toward CAI or computers has become an important concept because computers are a very common part of today's schools in all grades. Although research in general education courses produced different results about students' attitudes toward CAI (A_kar et al., 1992; Fratianni et al., 1990; Kraus et al., 1994; Vermette et al., 1986), research in physical education found that students had positive attitudes toward CAI and expressed their willingness to use CAI in future activities as a learning tool (Alvarez-Pons, 1992; Steffen & Hansen, 1985; Wilkinson et al., 1999).

Similar to these findings, the results of this study indicated that physical education majors had positive perception toward CAI. Furthermore, students reported that the sequential approach of CAI was very helpful to learn in a systematic way. On the other hand, some of the students felt that CAI was very repetitive and boring, and some technical problems occurred during the practice. In general, PETE majors had positive attitudes toward CAI and reported that they would like to use CAI in other PETE method courses as a way of instruction. Only one student indicated negative comment about this. However, there is very limited research data about PETE majors' perceptions toward CAI and this study reflects only a small sample size as a research population. Therefore, more research studies are needed in this area to determine students' perceptions in the future. The attitudes of PETE majors toward CAI were determined via three open ended short answer questions in this study as a minor research question. Future studies should use in-depth research strategies such as continuous interviews from pre to post interventions, surveys, and journals to get more insight about students' perception.

Conclusions

The main purpose of this study was to determine the effects of multimedia CAI on PETE majors teaching of the serve in tennis. Chapter Five provided information and discussion about the five main research questions asked in this study.

Overall, the TI intervention was very dominant in the results. The TI group performed significantly better in the tennis serve content knowledge test, tennis serve task analysis test, PCK-Appropriate cues, and PCK-Appropriate demonstration. However, the CAI group was successful in the tennis serve content knowledge test and PCK-Appropriate demonstration.

Interestingly, none of the groups were successful in the tennis serve skill analysis test and PCK-Appropriate feedback. Finally, students' perception toward CAI was positive in general and students indicated that they would like to use CAI in other PETE method courses. However, some of the students reported that CAI was very repetitive, and also technical problems were reported.

There is very limited research information about the effects of CAI in physical education and PETE. In addition, the results of research studies conducted in general education and other subject matters provided conflicting results about the effectiveness of CAI. However, the 21st century will be an information age and computers will be an essential part of the education system in all grades and ages. Physical education teacher education programs and physical education lessons in K-12 education are no exceptions. Computers and instructional technology should be an integral part of PETE and K-12 physical education without sacrificing the physical activity.

Recommendations for the Future Research

The following recommendations are provided for future research:

1-The Present study used only 60 minutes of intervention for both CAI and teacher instruction. Research shows that longer interventions are effective to produce intended outcomes. Future studies should consider having prolonged intervention time in CAI.

2-This study used only the serve skill element in tennis. Future studies should look also at the teaching of forehand, backhand, lob, volley and smash skills in tennis via CAI.

3- Longer intervention of CAI with testing all of the skill elements in tennis would be a good idea to see the differences between skills and task difficulty.

4-Pedagogical Content Knowledge (PCK) is a very unique blend of knowledge that leads to development of teachers in many ways. However, six minutes microteaching units are not enough time to test students' PCK. Therefore, future studies should provide longer and multiple microteaching periods to understand PCK in depth.

5-Multiple methodologies in a prolonged time period should be provided as an intervention such as text and CAI or teacher instruction, and CAI instead of just a single intervention.

6-CAI still can be used as a way of intervention to provide content knowledge. However, duration, method of delivery, and cognitive level of students should be considered very carefully in future studies and interventions.

7-Although this study could not find any significant results about the effects of CAI on skill analysis; there is still need for skill analysis research in CAI because this is such an important part of teaching quality in PETE. Future studies focus on different application and assessment strategies for skill analysis in CAI.

8- Students' perceptions toward CAI were positive in general. However, several technical problems were reported and some students found CAI repetitive and boring. Future researchers should be very careful about designing CAI programs to overcome design issues. More interactive multimedia with different approaches could be a way of doing this.

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APPENDIX A

DESCRIPTIVE TABLES

Table 1

Descriptive Data of Tennis Serve Content Knowledge Pre-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	3.00	12.00	7.50	2.88
CAI	6	4.00	9.00	7.00	1.78
CG	6	7.00	10.00	8.16	1.16

Table 2

Descriptive Data of Tennis Serve Content Knowledge Post-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	12.00	15.00	13.0	1.26
CAI	6	10.00	13.00	11.33	1.36
CG	6	8.00	11.00	9.33	1.03

Table 7

Descriptive Data of Tennis Serve PCK-Appropriate Cues Pre-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	.00	2.00	.50	.83
CAI	6	.00	1.00	.83	.40
CG	6	.00	1.00	.50	.54

Table 8

Descriptive Data of Tennis Serve PCK-Appropriate Cues Post-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	5.00	9.00	6.5	1.51
CAI	6	.00	13.00	4.00	3.22
CG	6	.00	3.00	1.33	1.21

Table 13

Descriptive Data of Tennis Serve PCK-Appropriate Feedback Pre-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	.00	1.00	.16	.40
CAI	6	.00	1.00	.33	.51
CG	6	.00	.00	.00	.00

Table 14

Descriptive Data of Tennis Serve PCK-Appropriate Feedback Post-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	.00	1.00	.50	.54
CAI	6	.00	2.00	.33	.81
CG	6	.00	.00	.00	.00

Table 16

Descriptive Data of Tennis Serve PCK-Appropriate Demonstration Pre-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	.00	1.00	.50	.54
CAI	6	.00	2.00	.83	.75
CG	6	.00	2.00	.50	.83

Table 17

Descriptive Data of Tennis Serve PCK-Appropriate Demonstration Post-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	3.00	8.00	5.33	1.75
CAI	6	1.00	8.00	3.83	2.78
CG	6	.00	3.00	.66	1.21

Table 22

Descriptive Data of Tennis Serve Skill Analysis Pre-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	21.00	28.00	25.83	2.78
CAI	6	18.00	28.00	22.33	3.77
CG	6	12.00	21.00	17.66	3.44

Table 23

Descriptive Data of Tennis Serve Skill Analysis Post-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	25.00	28.00	27.16	1.32
CAI	6	22.00	31.00	27.50	3.01
CG	6	12.00	23.00	18.66	4.17

Table 25

Descriptive Data of Tennis Serve Task Sequence Pre-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	00.00	7.00	4.00	2.60
CAI	6	2.00	11.00	5.00	3.09
CG	6	00.00	9.00	4.83	3.25

Table 26

Descriptive Data of Tennis Serve Task Sequence Post-Test

Group	N	Minimum	Maximum	Mean	SD
TI	6	17.00	31.00	25.00	6.16
CAI	6	5.00	25.00	13.16	8.15
CG	6	2.00	18.00	9.00	5.13

APPENDIX B

VTPE TENNIS SERVE CONTENT TEACHER INSTRUCTION OUTLINE

READY PHASE (INCORRECT)

- 1-Body is not siding to the net, shoulders face to net.
 - 2-Forward foot (leading foot) is perpendicular, not toward right angle to the net at 45 degree; back foot is not parallel to the base line.
 - 3-Hands are not at waist level with racket and ball (at very low level) and racket is down (not showing the target).
 - 4-Ball is on the palm of hand (not on the fingers).
-

READY PHASE (CORRECT)

- 1-Body sides to net.
 - 2-Forward foot (leading foot) toward right angle to the net at 45 degree.
 - 3-Backfoot is parallel to the net.
 - 4-Hands are at waist level and pointing the target.
 - 5-Ball is resting on the fingers.
-

GRIP PHASE (INCORRECT)

- 1-Trigger finger is not closed and parallel to the handle.
 - 2-V Shape is not formed with index finger and thumb.
-

GRIP PHASE (CORRECT)

- 1-Eastern Forehand Grip.
 - 2-Hold the racket with your palm of hand.
 - 3-Shakehand Grip with racquet.
 - 4-V shape formed with index finger and thumb.
-

SWING PHASE (INCORRECT)

- 1-Ball released in low level from chest and shoulders (not eye level).
 - 2-Ball released in front of the body not above the head.
 - 3-Ball released in behind the body.
 - 4-Elbow drops early (not 90 degree).
 - 5-Racket head is behind the head not between the shoulders.
 - 6-Ball tossed very high and does not contact at peak point.
 - 7-Hand did not point at the ball.
-

SWING PHASE (CORRECT)

- 1-Ball released at eye level.
 - 2- 3-Elbow at 90 degree.
 - 3-Racket head between the shoulders.
 - 4-Hand pointed at the ball.
-

CONTACT PHASE (INCORRECT)

- 1-Racket head did not contact with the ball at peak point.
 - 2-Racket face is not square to the ball.
 - 3-No wrist snap at ball contact.
-

CONTACT PHASE (CORRECT)

- 1- Racket at head contacts with the ball at peak point.
 - 2- Racket face is square to the ball.
 - 3- Player uses wrist snap at ball contact.
-

FOLLOW THROUGH PHASE (INCORRECT)

- 1-Racket head did not point toward target.
- 2-Racket arm did not cross the body.
- 3-Body weight did not transfer into the net.
- 4-Player did not hold in the finish.

FOLLOW THROUGH PHASE (CORRECT)

- 1-Racket points toward the target.
 - 2-Racket arm crosses the body and makes an X.
 - 3-Body weight is transferred toward the net.
 - 4-Hold in the finish
-

PROTOCOLS FOR INTEROBSERVER AGREEMENT

Please look at the following protocols very carefully to determine interobserver agreement (IOA) for study.

1-In this study, IOA will be determined by the occurrence and nonoccurrence of specific teaching behaviors in microteachings such as feedback, demonstrations, and cues.

2-Please follow the VTPE Tennis Serve Teacher Instruction Outline strictly to determine specific teaching behaviors that you observed on videotape.

3- Ignore the irrelevant teaching behaviors that occurred on videotape and only record behaviors that are stated teacher instruction outline.

3-Analyze every videotape two times in a row to observe specific teaching behaviors consistently in detail.

4-IOA will be determined by using a formula of interobserver agreement. This formula will be calculated by determining the total number of agreements and dividing that number by the total number of agreement plus disagreements. Then multiply that number by 100 to achieve a percentage. The formula is as follows:

$$\frac{\text{Agreements}}{\text{Agreements} + \text{Disagreements}} \times 100 = \text{Percentage of agreement}$$

5-Please remember an eighty-percent IOA criteria was set before analyzing the videotapes.

6-Analyse the videotapes separately from main investigator using the PCK observation sheet and compare the results using the formula above.

7-The tapes will be selected randomly for observation and at least 20 % of videotapes will be analyzed to determine IOA.

APPENDIX C

VTPE TENNIS SERVE CONTENT KNOWLEDGE TEST

Student Name:

Group: (Please circle it)

Teacher Instruction (TA), Computer-Assisted Instruction (CAI), Control Group (CG)

Directions: Please choose the best answer for the following questions (Please answer each questions for a right handed player and flat serve)

1- Which of the followings is the correct grip for tennis serve?

- a) Continental grip
- b) Western grip
- c) Eastern forehand grip
- d) Semi-western grip

2- What is the position of racket hand in tennis serve grip?

- a) Thumb and index finger makes a “V” directly on the top of handle
- b) Thumb and index finger makes a “V” directly on the left of handle with shake hand grip
- c) Thumb and index finger makes a “V” using palm of hand with shake hand grip
- d) Thumb and index finger makes a “V” directly on the left of handle

3-What is the position of body in tennis serve ready position?

- a) Body is parallel to the net
- b) Body sides to net
- c) Body is at 90 degree angle to the net
- d) Body is perpendicular to the net and baseline

4-. Which statement is best describes the position of forward (leading) foot in tennis serve ready position?

- a) The forward foot is parallel to base line at a 90 degree angle
- b) The forward foot is perpendicular to baseline at a 90 degree angle
- c) The forward foot is parallel to base line at a 45 degree
- d) The forward foot is at a 45 degree angle to the baseline and net

5- Which statement is describes best how to hold a tennis ball?

- a) Ball on the palm of the hand
- b) Ball on the fingers
- c) Ball on the thumb and index finger
- d) Ball on the inside of the hand

6- In tennis serve, the ball should be released in which level?

- a) Shoulders and chest
- b) Chin
- c) Above the head
- d) Eye

7- What is the position of hands in tennis serve ready position?

- a) Hands are at shoulders level
- b) Hands are at waist level and pointing the target
- c) Hands are at chest level and pointing the target
- d) Hands are at eye level and pointing the target

8- In the back scratch position for tennis serve, where should the racket head be?

- a) The racket head should be between the shoulders
- b) The racket head should be behind the head
- c) The racket head should be right of the spine
- d) The racket head should be left of the spine

9- In the contact position for tennis serve, where should the racket head be?

- a) The racket head should be in front of the forward foot
- b) The racket head should be behind the front foot
- c) The racket head should be above the front shoulder
- d) The racket head should be behind the front shoulder

10- In the backscratch position for tennis serve, what is the position of elbow?

- a) Elbow at 45 degree behind the body
- b) Elbow is behind the head
- c) Elbow at 90 degree behind the body
- d) Elbow is behind the shoulders

11- In the tennis serve, ball should be travel _____ in relation to the height

- a) As much as high
- b) At eye level
- c) Above the head
- d) As high as extended racket

12- In contact phase for tennis serve, where the racket contacts with the ball in relation to the height?

- a) In front of the body
- b) At peak point
- c) Behind the body
- d) Slightly in front of the body

13- In contact phase for tennis serve, racket face should be _____ to the ball

- a) Flat
- b) Perpendicular
- c) Square
- d) Sided

14- In follow through phase for tennis serve, the racket head should _____

- a) Not point toward the target
- b) Cross the body toward non-racket arm
- c) Not cross the body
- d) Cross the body toward right side

15- In the finish of tennis serve, what is the position of racket hand?

- a) Racket hand should cross the body and hold in the finish
- b) Racket hand should not cross the body
- c) Racket hand should point toward the target
- d) Racket hand should cross the body toward right side

16- What is the main cause of bending the elbow during contact phase in tennis serve?

- b) Tossing the ball behind the body
- c) Tossing the ball above the head
- d) Tossing the ball very high
- e) Tossing the ball too low

17- What is the main cause of hitting the net during tennis serve?

- a) Tossing the ball very high
- b) Tossing the ball above the head
- c) Tossing the ball too far out front
- d) Tossing the ball behind the body

VTPE TENNIS SERVE CONTENT KNOWLEDGE TEST KEY

1-C

2-C

3-B

4-D

5-B

6-D

7-B

8-A

9-A

10-C

11-D

12-B

13-C

14-B

15-A

16-D

17-C

APPENDIX D

VTPE TENNIS SERVE SKILL ANALYSIS TEST

Student Name:

Group: Please circle it

Teacher Instruction (TA), Computer-Assisted Instruction (CAI), Control Group (CG)

Directions: For each of the segment please answer the following three choices as

Y= Yes definitely observed

N= No definitely not observed

Segment 1 (GRIP)

Y N

Eastern Forehand Grip

Continental Grip

Shake Hand Grip with racket

Segment 2 (READY)

Hands are at waist level

Body sides to net

Back foot is parallel to the net

Segment 3 (READY)

Y N

Leading (forward) foot to the net at 45 degree angle

Body sides to net

Hands are at waist level

Segment 4 (READY POSITION)

Hands are at waist level and pointing the target

Body is siding to the net

Ball on the top of fingers

Segment 5 (RELEASE)

Ball released at eye level

Hand pointed at the ball

Ball on the top of the fingers

-

Segment 6 (TOSS)

Hand pointed at the ball

Racket head is between the shoulders

Ball released above the head

Segment 7 (SWING)

Y N

Elbow at 90-degree

Racket head is between the shoulders

Ball released behind the body

Segment 8 (TOSS)

Racket arm bend with elbow tucked close to body

Ball tossed very high

Hand pointed at the ball

Segment 9 (CONTACT)

Racket face is square to the ball

Racket head contacts with the ball at peak point

Hand pointed at the ball

Segment 10 (CONTACT)

Racket head contacts with the ball at peak point

Player timing was off

Player hit the ball behind his head

Segment 11 (FOLLOW THROUGH)

Y N

Racket points toward target

Racket arm cross the body and makes an X

Body weight transfer toward the net

Segment 12 (FOLLOW THROUGH)

Player hold racket in the finish

Racket arm cross the body and makes an X

Body weight transfer toward the net

VTPE TENNIS SERVE SKILL ANALYSIS TEST KEY

SEGMENT 1

Y

N

Y

SEGMENT 2

Y

N

N

SEGMENT 3

Y

Y

N

SEGMENT 4

Y

Y

N

SEGMENT 5

Y

N

Y

SEGMENT 6

Y

N

N

SEGMENT 7

Y

Y

N

SEGMENT 8

Y

Y

N

SEGMENT 9

Y

N

Y

SEGMENT 10

Y

N

N

SEGMENT 11

Y

N

N

SEGMENT 12

Y

Y

Y

APPENDIX E

VTPE TENNIS SERVE TASK SEQUENCE TEST

Student Name:

Group: Please circle it

Teacher Instruction (TA), Computer-Assisted Instruction (CAI), Control Group (CG)

In the space provided below, please list the names of the appropriate **TASKS** and **CUES** for each task in the correct sequence (List the tasks in an order) for the **TENNIS SERVE**.

****For example:** A correct task sequence for **Soccer Instep** kick will be APPROACH RUN, LEG SWING, FOOT PLACEMENT, KICK, AND FOLLOW THROUGH.
And appropriate teaching cues for **Basketball Free Throw** will be ELBOW 90 DEGREE, BEND THE KNEE, EYE ON THE BALL, PLACE A BOOK ON THE TOP OF A SHELVE

TASK 1 -----

CUES TASK 1 (Please list 3 cues)

1-----

2-----

3-----

TASK 2

CUES TASK 2 (Please list 5 cues)

- 1-----
- 2-----
- 3-----
- 4-----
- 5-----

TASK 3

CUES TASK 3 (Please list 5 cues)

- 1-----
- 2-----
- 3-----
- 4-----
- 5-----

TASK 4

CUES TASK 4 (Please list 3 cues)

- 1-----
- 2-----
- 3-----

TASK 5

CUES TASK 5 (Please list 4 cues)

- 1-----
- 2-----
- 3-----
- 4-----

VTPE TENNIS SERVE TASK SEQUENCE TEST KEY

Student Name:

Group: Please circle it

Teacher Instruction (TA), Computer-Assisted Instruction (CAI), Control Group (CG)

In the space provided below, please list the names of the appropriate **TASKS** and **CUES** for each task in the correct sequence (List the tasks in an order) for the **TENNIS SERVE**.

****For example:** A correct task sequence for **Soccer Instep** kick will be APPROACH RUN, LEG SWING, FOOT PLACEMENT, KICK, AND FOLLOW THROUGH.

And appropriate teaching cues for **Basketball Free Throw** will be ELBOW 90 DEGREE, BEND THE KNEE, EYE ON THE BALL, PLACE A BOOK ON THE TOP OF A SHELVES

TASK 1
GRIP

CUES TASK 1 (Please list 3 cues)

- 1-Hit with palm of hand
- 2- V formed by thumb and index finger
- 3- Shake hand with racquets

TASK 2

READY

CUES TASK 2 (Please list 5 cues)

- 1-Body sides to net
- 2-Forward foot (leading foot) toward right angle to the net at 45 degree
- 3-Backfoot is parallel to the net
- 4-Hands are at waist level and pointing the target
- 5-Fingers on the ball

TASK 3

SWING

CUES TASK 3 (Please list 4 cues)

- 1-Ball released at eye level
- 2-Elbow at 90 degree
- 3-Racket head between the shoulders
- 4-Hand pointed at the ball

TASK 4
CONTACT

CUES TASK 4 (Please list 3 cues)

- 1-Racket head contacts with the ball at peak point
- 2-Racket face is square to the ball
- 3-Player uses wrist snap at ball contact

TASK 5
FOLLOW THROUGH

CUES TASK 5 (Please list 4 cues)

- 1-Racket points toward target
- 2-Racket arm cross the body and makes an X
- 3-Body weight transfer toward net
- 4-Hold in the finish

APPENDIX F

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants of Investigative Projects

Title of Project: The Effects of Multimedia Tennis Computer-Assisted Instruction (CAI) on Teaching Tennis

Investigator(s): Dr. George Graham, Ferman Konukman,

I. The Purpose of this Research/Project

The purpose of this study is to determine the effects of multimedia computer-assisted instruction on teaching tennis. Approximately, 20 undergraduate physical education teacher education students randomly will be assigned into three groups: CAI, Control Group (CG) and Teacher Instruction (TI). (CAI) Computer Assisted Instruction is a computer tutorial program that provides a comprehensive approach for teaching tennis. It includes videos of the basic strokes, pictorial information and quizzes on equipment, rules, etiquette, skill analysis and, strategy.

II. Procedures

Students randomly will be assigned into three different groups as CAI group, Control Group and Teacher Instruction group. **If you are assigned to CAI group** and voluntarily agree to participate, a cognitive multiple choices, paper and pencil test and skill analysis test will be administrated about serve in tennis as a pre and post-tests at the beginning and end of micro teaching units during regular course hours. In addition to this, you will be teaching and video taped two 4-6 minutes microteaching tennis serve units as a pre and post to determine Pedagogical Content Knowledge (PCK). Finally, an open ended three questions will be asked about your perceptions toward CAI. These paper and pencil tests will take 10-15 minutes. Moreover, You will be getting Computer-Assisted Instruction (CAI) as an hour intervention prior to your second microteaching.

CAI is a computer tutorial program that provides a comprehensive approach for teaching tennis. It includes videos of the basic strokes, pictorial information and quizzes on equipment, rules, etiquette, skill observation and, strategy.

III. Benefits and Risks of this project

There is not any risk for students as being part of this project but we cannot guarantee any benefits from this project to participants. However, Results of this project may lead to development in physical education teacher education and collegiate tennis instruction. Moreover, this could provide a new knowledge in the area for quality instruction.

FIGURE A

**VTPE PEDAGOGICAL CONTENT KNOWLEDGE (PCK) OBSERVATION
SHEET**

Student Name:

Group: Please circle it

Teacher Instruction (TA), Computer-Assisted Instruction (CAI), Control Group (CG)

# of CUES		# of FEEDBACK		# of DEMONSTRATIONS	
Appropriate A	Inappropriate I	Specific Congruent	Incongruent	Appropriate A	Inappropriate I
		A	I		

CURRICULUM VITA

Ferman Konukman was born on July 18, 1969 in Ankara, Turkey. He completed Bachelor of Science degree at Middle East Technical University (METU), Department of Physical Education & Sports on July 1994. After graduation he worked as a research assistant at Abant Izzet Baysal University, School of Physical Education and Sports in Bolu, Turkey. In 1995, he was awarded with a scholarship by Ministry of National Education to complete Master and Ph. D degrees in USA. He completed his first Master of Education degree at The University of Nebraska Lincoln, Department of Health & Human Performance in Physical Education & Sport Studies in 1998. After graduation he enrolled at Virginia Polytechnic Institute & State University, Division of Health & Physical Education in Blacksburg, VA and completed his second Master of Science degree in Health Promotion in 2003. Currently, he is a lecturer at Central Washington University, Department of Health, Human Performance & Recreation in Ellensburg, WA.