The Effect of Using Computer Simulations as Self-Directed Learning on Critical
Thinking Levels in Entry-Level Athletic Training Students

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Markéta Schübllová

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by

MARKÉTA SCHÚBLOVÁ

has been approved for
the Department of Teacher Education
and the College of Education by

Ralph E. Martin, Jr.
Professor of Teacher Education

Renée A. Middleton
Dean, College of Education
ABSTRACT

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The Effect of Using Computer Simulations as Self-Directed Learning on Critical Thinking Levels in Entry-Level Athletic Training Students (184 pp.)

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One goal of healthcare educators is to help students think critically to solve problems. Problem-based learning (PBL) is a process that promotes active learning using critical thinking (CT). An assumption is that athletic training students learn CT skills by engaging in the elimination process to correctly answer multiple-choice questions. The purpose of this study is to answer whether implementing a PBL self-directed learning method via computer simulations effects entry-level athletic training students’ performance on computer simulations related to physical evaluation of athletic injuries.

The California Critical Thinking Skills Test (CCTST) was used to evaluate participants’ CT. Participants were divided into two groups, higher level CT (M=72.65%) and lower level CT (M=33.06%). Participants then completed the Computerized-Traditional Athletic Training Simulation Instrument prior to and after completing four weeks of self-directed learning. A repeated measures ANOVA within and between subjects revealed no significant difference between pre-test and post-test performance by their CT level, Wilks’ Lambda =.975, F(1,30)=.775, p=.386, multivariate $\eta^2_p=.025$. 
Participants received unlimited access to computer case simulations from www.higherlevelthinking.com as the treatment measure. A repeated measures ANOVA showed no significant effect of students’ CT level on their performance on five computer simulations, $F(2.03, 60.92)=.447, p=.645$. A repeated measures ANOVA test of between-group effect was conducted $F(1, 30)=1.84, p=.186$, and revealed no significant difference in mean performance scores between the two groups.

Participants appeared to score better on the computer simulation 3 *BOC Mock Exam* compared to the other four computer simulations. Using pairwise comparisons, it was found that participants’ performed significantly better on computer simulation 3 ($M=77.12\%$), $p<.01$ than on all other cases.

Additionally, a repeated measures ANOVA determined that a significant difference occurred between participants’ grade point average (GPA) in athletic training classes and their performance on the CCTST, $F(2.58, 77.49)=4.68, p=.007$. Based on this study, computer simulations do not evaluate the decision making thinking process, and thus, should not be used as an evaluation tool for assessing CT in athletic training students regarding physical evaluation of athletic injuries. However, it was determined that participants’ cumulative GPA and GPA in athletic training classes do reflect their ability to think critically.

Approved: _______________________________________________

Ralph E. Martin, Jr.

Professor of Teacher Education
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TABLE OF CONTENTS

Abstract .................................................................................................................. 3
Acknowledgments ................................................................................................... 5
List of Tables ......................................................................................................... 12
List of Figures ....................................................................................................... 14
CHAPTER ONE: INTRODUCTION ....................................................................... 15
  Overview of the Study ....................................................................................... 15
  Higher Education ............................................................................................. 15
  The Athletic Training Profession .................................................................... 16
  Athletic Training Education ............................................................................ 19
  Computer Based Testing .................................................................................. 21
  Statement of the Problem ............................................................................... 22
  Purpose of the Study ....................................................................................... 24
  Research Questions ......................................................................................... 25
  Null Hypothesis .............................................................................................. 25
  Significance of the Study ............................................................................... 26
  Assumptions .................................................................................................... 26
  Delimitations ................................................................................................... 27
  Limitations ....................................................................................................... 27
  Definition of Terms ........................................................................................ 28
  Summary ......................................................................................................... 31
CHAPTER TWO: LITERATURE REVIEW .............................................................. 32
Additional Data Analysis .................................................................114
Summary .............................................................................................131
CHAPTER FIVE: SUMMARY, DISCUSSION, and CONCLUSION ...............132
Summary .............................................................................................132
Summary of Quantitative Findings .......................................................135
   Different Levels of Critical Thinking and Performance on Computer Simulations: $H_{01}$ .............................................................135
   Comparison of the Means of Participants’ Performances on Five Computer Simulations between the Critical Thinking Level Groups: $H_{02}$ .............................................................137
   Comparison of Participants’ Performance on Five Computer Simulations: $H_{03}$ .............................................................138
Additional Findings .............................................................................140
Summary and Conclusion of this Study ..............................................145
Recommendations for Further Study ..................................................148
REFERENCES ...................................................................................151
APPENDIX A: Recruiting Letter .........................................................174
APPENDIX B: Informed Consent Form ...............................................175
APPENDIX C: Subject’s Questionnaire ...............................................179
APPENDIX D: The California Critical Thinking Skills Test ..................180
APPENDIX E: Practice Computer Case Studies ..................................181
APPENDIX F: Computerized-Traditional Athletic Training Simulation Instrument ....182
APPENDIX G: Testing Site IRB Approval ......................................................... 183

APPENDIX H: Ohio University IRB Approval .................................................... 184
LIST OF TABLES

Table 1: Clinical Education-Setting Standards ..................................................36
Table 2: Educational Tools Promoting Critical Thinking in Higher Education ........53
Table 3: Elements of Effective Computer Simulation........................................71
Table 4: Scoring Rubric for C-TATSI................................................................99
Table 5: Dependent and Independent Variables Used in this Study ..................100
Table 6: California Critical Thinking Skills Test: Groups’ Demographics ..........104
Table 7: Participants’ QPA and ATGPA ...............................................................105
Table 8: California Critical Thinking Skills Test Results ..................................106
Table 9: Mean and Standard Deviation of California Critical Thinking Test Score.107
Table 10: Completed Practice Computer Simulations ..........................................108
Table 11: Participants’ Performance on Computer Simulations Based on Their
Level of Critical Thinking Group Assigned .....................................................110
Table 12: Group Statistics for Performance Mean on Computer Simulations
between Higher-Level and Lower-Level Critical Thinking Groups ...............112
Table 13: Estimated Marginal Means for Five Computer Simulations ...............113
Table 14: Pairwise Comparisons of Five Computer Simulations .......................114
Table 15: Pre-Test and Post-Test Performance on C-TATSI for Low Practice and
High Practice Groups ......................................................................................117
Table 16: Pre-Test and Post-Test Performance on C-TATSI for Higher-Level
and Lower-Level Critical Thinking Groups ...................................................119
Table 17: Pre-Test and Post-Test Performance on C-TATSI Based on Participants’
ATGPA and QPA........................................................................................................... 120

Table 18: Comparing Specific Portion of the CCTST by Grade Level.................. 121

Table 19: Higher-Level and Lower-Level Critical Thinking Groups Computer
Simulation Means ...................................................................................................... 123

Table 20: Participants’ Performance on Computer Simulations Based on Their
Class Rank ............................................................................................................... 124

Table 21: Higher and Lower QPA Groups’ California Critical Thinking Skills Test
Scores ....................................................................................................................... 125

Table 22: Higher and Lower ATGPA Groups’ Means Scores on Each Section of the
California Critical Thinking Skills Test ................................................................. 127

Table 23: Means Scores on Computer Simulations Based on QPA..................... 129

Table 24: Means Scores on Computer Simulations Based on ATGPA ............... 130
LIST OF FIGURES

Figure 1: Comparison of the Means on the Five Computer Simulations between the Higher-Level and Lower-Level Critical Thinking Groups .......................... 111

Figure 2: Comparison of the Means on Pre-Test and Post-Test C-TATSI between Higher and Lower Practice Groups ...................................................... 116

Figure 3: Comparison of the Means on Pre-Test and Post-Test C-TATSI between the Higher and Lower Level of Critical Thinking Groups .......... 118

Figure 4: Comparison of the Participants’ Scores on the CCTST Sections Based on Their Class Rank .................................................................................. 122

Figure 5: Comparison of the Participants’ Scores on the Five Computer Simulations Based on Their Class Rank ......................................................... 124

Figure 6: Comparison of the Participants’ Scores on the CCTST Sections Based on Their QPA ......................................................................................... 126

Figure 7: Comparison of the Participants’ Scores on the CCTST Sections Based on Their ATGPA ................................................................................. 128

Figure 8: Comparison of the Participants’ Scores on the Five Computer Simulations Based on Their ATGPA ........................................................................ 130
CHAPTER ONE: INTRODUCTION

Overview of the Study

Higher Education

Higher education is a dynamic process offering various instructional methods of educational material delivery to students. According to Chen and Willits (1999), there have been dramatic changes in “alternative instructional delivery” systems within the past couple of decades.

While the main role of educators continues to be to prepare skilled professionals by helping students to learn in an effective and efficient manner (Newble & Entwistle, 1986), one of the main goals of healthcare educators in particular today is to help students to learn to think critically and to solve problems rather than simply identify correct answers (Miller, 1992; Starkey, Koehneke, Sedory, & Turocy, 2004). It is for this reason that many medical schools adopt problem-based learning.

Problem-based learning (PBL) is a student-driven process that promotes active learning by placing emphasis on research, planning, higher-level thinking, critical thinking, and problem solving (Barrows, 1990; Charlin & Mann, 1998). By using a sample of real-world problems to provide students with an alternative form of educational material delivery, PBL improves students’ clinical reasoning and professional preparation (Davis & Harden, 1999; McGee, 2003). It increases the active learning process, allowing students to engage in a realistic problem with enthusiasm, initiative, and motivation, thus promoting critical thinking (Heinrichs, 2002).
The Athletic Training Profession

Interest in sports is growing globally, and the likelihood of one sustaining an injury while participating in sports is growing at an even greater rate. The National Center for Catastrophic Sport Injury Research reported 833 direct and 415 indirect catastrophic injuries—that is, sports injuries resulting in death or permanent paralysis—in high school athletics between 1982 and 2006 (National Center for Catastrophic Sport Injury Research, Retrieved March 27, 2008). Two hundred eighty-eight of the 833 direct catastrophic injuries and 407 of the 415 indirect catastrophic injuries resulted in death. In addition, college athletics reported 197 direct catastrophic injuries with 11 fatalities, and 97 indirect catastrophic injuries with 94 fatalities (National Center for Catastrophic Sport Injury Research, Retrieved March 27, 2008). Thus, the need for qualified professionals providing the prevention, treatment, and rehabilitation of athletic injuries is more crucial than ever.

Athletic Training is an allied healthcare profession, recognized by the American Medical Association (AMA) (Delforge & Behnke, 1999). Certified athletic trainers (ATCs) are healthcare professionals who work in conjunction with physicians and other healthcare professionals, and specialize in the prevention, diagnosis, treatment, and rehabilitation of sports injuries and illness. A certified athletic trainer must be competent within the realms of pharmacology and orthopedic diagnostics, as well as able to diagnose common diseases and illnesses by their signs and symptoms (McGee, 2003).

Athletic trainers face complex problems that require critical thinking on a daily basis (Fuller, 1997; Oermann, 1997; Walker, 2003). They need to be able to quickly
ascertain the depth of any situation with which they are presented, and decide upon an appropriate action and treatment based on their available background knowledge, experience, and skills (Allen, Bowers, & Diekelmann, 1989; Fuller, 1995; Heinrichs, 2002). According to Starkey (1997), certified athletic trainers “. . . are the original multi-skilled healthcare providers . . .” as they are “. . . responsible for preventing injury and illness, for evaluation/management, for rehabilitations, for counseling, and for [educating their] clientele” (p. 113). Certified athletic trainers working within an accredited athletic training education program must be educators as well as care providers for their athletes. That is, they must fill a role similar to that of physicians working in teaching hospitals (Carr & Drummond, 2002).

To become a board-certified athletic trainer, students sit for a national certification examination. The purpose of the Board of Certification (BOC) examination is to discriminate objectively between individuals who can and who cannot demonstrate minimal competence as outlined in the National Athletic Trainers’ Association Role Delineation Study (BOC, Retrieved April 9, 2008). Because of the high expectations placed upon athletic trainers, the BOC examination—unlike other allied healthcare professional board examinations—includes both multiple-choice questions and hybrid problems. Many other professional examinations require passing only a written multiple-choice examination (Turocy, Comfort, Perrin, & Gieck, 2000).

The BOC examination consists specifically of 125 multiple-choice questions and four hybrid problems, as well as several unscored field test items (BOC, Retrieved January 26, 2008). During the computer-based hybrid problem portion of the
examination, athletic training students are presented with scenarios similar to those they might experience in clinical practice. This portion of the exam consists of a combination of multiple-choice questions, drag-and-drop questions, N-wise multiple-choice questions, animated simulations, and hot spots (BOC, Retrieved March 25, 2008). It therefore is considered to be a cued-format examination (BOC, Retrieved January 26, 2008). After athletic training students make each selection during this portion of the exam, the appropriate response is revealed, and the examinee then continues with the simulation. By providing feedback to examinees, hybrid problems allow students to continually evaluate the situation and review their previous steps in order to decide upon the next step that should be taken. Therefore, critical thinking is promoted.

While the BOC exam combines both multiple-choice questions and hybrid problems, however, today’s entry-level educators use multiple-choice examinations a majority of the time to test and evaluate students’ performance (Barach, Satish, & Streufert, 2001). Unfortunately, this form of testing does not accurately assess students’ reactions in real-life situations. Walsh & Seldomridge (2006) stated that multiple-choice exams reward recognition and recall only, and do not encourage students to think critically. Problem-based simulation learning, on the other hand, allows students to become active listeners and problem solvers as they learn to view material more critically by making decisions based on the feedback provided to them (Bernstein, Scheerhorn & Ritter, 2002).
Athletic Training Education

Effective June 30, 2006, all athletic training education programs (ATEPs) must be accredited by the Commission on Accreditation of Athletic Training Education, or CAATE (CAATE, Retrieved June 28, 2008). These accredited ATEPs must expose athletic training students to the knowledge and skills found in the *NATA Athletic Training Educational Competencies*. These competencies are derived from clinical proficiencies, and include measurable objectives that athletic training students have to master (NATAEC, Retrieved June 28, 2008). The competencies set forth by the National Athletic Trainers’ Association Education Council (NATAEC) and adopted by CAATE are divided into twelve content areas, each consisting of specific knowledge and skill set requirements for the entry-level athletic trainer. These areas are divided further into cognitive and psychomotor competencies, and clinical proficiencies (NATAEC, Retrieved January 19, 2008).

Athletic training students are to master the cognitive and psychomotor competencies and clinical proficiencies outlined by the CAATE prior to taking the BOC examination (Denegar & Hertel, 2002; Weidner & Henning, 2002). While assessment of athletic training students’ cognitive competencies allows an evaluation to be made of their understanding of the science, theory, and technique necessary to master the clinical proficiencies, evaluation of athletic training students’ manipulative and motor skill performance is a part of the psychomotor skills assessment (NATAEC, Retrieved June 28, 2008; Starkey et al., 2004). Clinical proficiencies, then, evaluate athletic training students’ integration of critical thinking and decision making skills (NATAEC, Retrieved...
June 28, 2008). The goal of these competencies is to prepare certified athletic trainers to handle the general aspects of healthcare (McGee, 2003).

During psychomotor skills assessment, athletic training students customarily are challenged to perform specific evaluation tests, state possible signs and symptoms of diseases and illnesses, identify anatomical landmarks, and identify possible complications. However, this type of skills assessment examines athletic training students’ memorization of facts only, as each psychomotor skill is tested independently and athletic training students are not, therefore, challenged to use critical thinking. Athletic training students benefit rather from the implementation of descriptive clinical proficiency testing, which allows both the cognitive competencies and the psychomotor skills. In this type of testing, athletic training students must analyze a problem, consider the presented facts, and make appropriate decisions about the evaluation of patients’ conditions (Starkey et al., 2004).

In 2002, Laurent and Weidner surveyed athletic trainers’ opinions on their clinical education. The respondents stated that 53% of their professional development related to decision making and communication came from clinical education. These data support the theory that appropriate clinical education is a vital part of becoming a professional (Laurent & Weidner, 2002).

The National Athletic Trainers’ Association Education Council (NATAEC) divides clinical education into two categories: clinical experiences and field experiences. Clinical experiences afford athletic training students the opportunity to both apply classroom knowledge and develop a sense of social responsibility as they integrate
psychomotor skills, cognitive skills, and clinical proficiencies while providing care to patients (Anderson et al., 1991; Edmond, 2001; Frish & Coscarelli, 1986; Jarski, Kulig, & Olson, 1990; Palmer, 2002; Slotnick, 1999; Starkey et al., 2004). Clinical experiences must be supervised directly by an approved clinical instructor (ACI) and aid socialization by allowing athletic training students to take part in professional practice (Jarski, Kulig, & Olson, 1990; NATAEC, Retrieved January 2, 2008; Starkey et al., 2004). Field experiences similarly provide athletic training students with the opportunity for informal learning in a clinical environment under the supervision of a clinical instructor (CI) or ACI. Field experiences take place in athletic training facilities, at athletic practices, and at competitive events (NATAEC, Retrieved September 27, 2007).

It is important to evaluate an athletic training student’s ability to synthesize individual skills into a larger scale as they progress through their education in the classroom and clinical settings (Starkey et al., 2004). This might be accomplished by evaluating athletic training students’ performances on computer simulation problem solving exercises and with multiple-choice exams, as well as athletic training students’ hands-on performances during their clinical education. This method would assess athletic training students’ abilities to combine and implement their practical knowledge more thoroughly than would using a simple checklist for skills performance (Starkey et al., 2004).

**Computer Based Testing**

Athletic training students are required to have adequate knowledge, sufficient clinical experience, and the ability to use critical and clinical thinking in clinical practice.
Problem-based simulation learning builds the foundation for clinical decision making by assisting athletic training students and other healthcare professionals in thinking beyond the recommended protocols, and thinking critically (Erickson-Owens & Kennedy, 2001). Based on Wagner’s (2002) study, directors of athletic training education programs strongly agree that athletic training students need critical thinking skills. However, only few of the directors believed that athletic training students actually develop the ability to apply their classroom knowledge in clinical settings through traditional educational processes.

In 2000, the Computerized-Traditional Athletic Training Simulation Instrument (C-TATSI) software was developed to provide eight simulations, each of which includes practice case studies containing 50 to 100 possible actions (Castle, 2000). Based on Castle’s (2000) study, athletic training students’ performance on the C-TATSI was similar to their performance on the written-simulation portion of the BOC exam, a former method of the BOC examination that was eliminated in June 2007.

Because of ever-changing instructional delivery methods, are athletic training educators appropriately preparing athletic training students to think critically? Are they using computer simulation to allow athletic training students to best develop critical thinking skills?

Statement of the Problem

Athletic training educators have the responsibility to educate and prepare athletic training students to become healthcare professionals. This includes presenting material necessary to prepare students to think critically. By presenting material solely via
traditional lecture sessions and without incorporating in-depth problem-based scenarios into these lectures, athletic training educators may not be preparing athletic training students to think critically. In fact, even when educators do integrate problem-based scenarios into their lectures, it is challenging to evaluate and discuss every possible step and consequence without the aid of computer technology; all the more so as class sizes increase and one-on-one time becomes more limited.

Therefore, an overarching question implied is: Are today’s entry-level athletic training students learning to think critically as they proceed through their programs of study? It typically is assumed that athletic training students learn to think critically in the classroom by engaging in the process of elimination necessary to determine the correct answer from the four to five possible answers presented in multiple-choice examinations. However, does this guided testing method truly promote critical thinking, or, rather, does problem-based simulation learning outpace guided testing when it comes to preparing athletic training students to think critically? This study seeks to answer this question by determining whether athletic training students’ critical thinking is reflected in their performance on computer simulation. The secondary purpose is determining whether implementing a problem-based self directed learning method, presented via computer simulation, for four weeks will have any effect on entry-level athletic training students’ performance on computer simulations related to physical evaluation. Other questions raised as a part of this study include:

1. Do all athletic training students benefit equally from self-directed learning using computer simulation?
2. Will students with different critical thinking skills perform differently on computer simulations?
3. Will performance differences occur over time?
4. Based on other four-year college students’ scores, where do the juniors and seniors athletic training students (attending this institution) scores stand regarding their performance on the California Critical Thinking Skills Test?

Overall, this study aims both to increase understanding of the benefits of self-directed learning using computer simulation and to help promote computer simulation use in entry-level athletic training education. Through this study, educators may better understand the possible factors influencing the critical thinking skills of athletic training students during their entry-level education. They may also see the advantages and disadvantages of the use of computer simulations in evaluating athletic injuries.

**Purpose of the Study**

The purpose of this study was to investigate if athletic training students’ performance on computer simulations on evaluation of athletic injuries reflects their critical thinking level. The secondary purpose of this study was to investigate whether using self-directed learning utilizing computer simulations over a four week period effects student performance on computer simulations related to the physical evaluation of athletic injuries. In the following section, each hypothesis is identified and analyzed for statistical significance.

To achieve the purposes of this study, the following questions were explored:
Research Questions

The following research questions (RQ) were used to frame this study:

RQ1: Do students who have lower levels of critical thinking skills perform the same on computer-simulations as students who have higher levels of critical thinking skills during a period of four weeks of self-directed learning?

RQ2: Do students with levels of higher critical thinking skills perform better on computer-simulations than students with a lower critical thinking skills level?

RQ3: When presented by computer-simulations as a self-directed learning tool for four weeks, do the students’ performances on completing computer-simulations improve?

Null Hypothesis

HO₁: There will be no significant difference in performance on computer simulations between the lower critical thinking skill level students group (lct) and the higher critical thinking skill level students group (hct). There will be no difference between the two groups’ of athletic training students and within their performance on the five computer simulations.

HO₂: There will be no significant difference in the means of scores of students’ performances on the computer simulations between the lower critical thinking skill level students group (lct) and the higher critical thinking skill level students group (hct).

\[
HO₂: \mu_{lct} = \mu_{hct}
\]

HO₃: There will be no significant difference in the students’ performances on five computer simulations over the period of four weeks.

\[
HO₃: \mu_{S1} = \mu_{S2} = \mu_{S3} = \mu_{S4} = \mu_{S5}
\]
Significance of the Study

This study will provide athletic training educators with valuable information regarding the usage of computer simulation as a self-directed learning supplement to Physical Evaluation of Athletic Injuries course. Educators will benefit by learning whether or not this self-directed learning method has a positive effect on students’ clinical reasoning as they solve medical case scenario problems. An additional gain will be that educators will discover whether or not there is any difference between higher-level and lower-level critical thinking skills athletic training students in the amount of benefit realized by utilizing computer simulation as a self-directed learning tool. Thus, athletic training educators will be better able to implement the variety of learning tools available to them during their Physical Evaluation of Athletic Injuries classes.

Branching out from traditional lecture methods that use textbooks and paper-and-pen scenarios to utilizing computer simulations as a self-learning method will benefit students. The unlimited possible scenarios available through the use of computer simulation will allow athletic training students the opportunity to solve in-depth medical problems that are impossible to cover in a classroom or even a clinical setting. This experience therefore furthers students’ athletic training knowledge.

Assumptions

1. The instruments were valid and reliable.
2. All participants performed to their best ability.
Delimitations

1. The data were delimited by the honesty and accuracy of the participants involved within the study.
2. The use of California Critical Thinking Skills Test to determine participants’ critical thinking skills level.
3. The use of Computerized-Traditional Athletic Training Simulation Instrument to evaluate participants’ ability to evaluate athletic injury via computer simulation.
4. The use of the website www.higherlevelthinking.com to assess participants’ ability to evaluate athletic injury via computer simulation.
5. The administration of the data collection at the second half of the spring semester when the majority of the senior athletic training students prepared for the BOC examination.

Limitations

1. This study was limited to junior and senior entry-level athletic training students in the Athletic Training Education Program at Pennsylvania State institution.
2. Differences in the participants’ perceived value of learning via computer simulation may have had an influence on their performance.
3. Differences in the participants’ academic preparation and computer simulation experience may have an influence on their performance.
Definition of Terms

The following terms are pertinent to this study and may have definitions that are different or unfamiliar. The researcher developed and utilized definitions specific to the use of the terms in this document:

- **Approved Clinical Instructor (ACI):** An appropriately credentialed professional identified and trained by the program clinical instructor educator (CIE) to provide instruction and evaluation of the athletic training education competencies and/or clinical proficiencies (NATAEC, Retrieved September 1, 2007).

- **Athletic Training Profession:** An allied healthcare profession recognized by the American Medical Association.

- **Athletic Training Student (ATS):** A student enrolled in the athletic training major or graduate major equivalent (NATAEC, Retrieved September 1, 2007).

- **Board of Certification (BOC):** An independent non-profit corporation responsible for the certification of entry-level athletic trainers and establishment of requirements for maintaining the status as a certified athletic trainer (BOC, Retrieved January 19, 2008).

- **Commission on Accreditation of Athletic Training Education (CAATE):** The agency responsible for the accreditation of 350+ professional (entry-level) athletic training educational programs. The CAATE provides comprehensive accreditation services to institutions that offer athletic training degree programs and verifies all accredited programs meet the acceptable educational standards for
professional (entry-level) athletic training education (BOC, Retrieved January 19, 2008).

- Certified Athletic Trainer (ATC): A healthcare professional who has met the credentialing requirements of the BOC. ATCs are responsible for prevention, evaluation, treatment, and rehabilitation of athletic injuries and illnesses.

- Clinical Education: The application of the knowledge and skills learned in classroom and laboratory settings to actual practice on patients under the supervision of an ACI/CI (NATAEC, Retrieved September 1, 2007).

- Clinical Experience: Those clinical education experiences for the athletic training student that involve patient care and the application of athletic training skills under the supervision of a qualified instructor (NATAEC, Retrieved September 1, 2007).

- Clinical Instruction: Daily personal contact and interaction by the clinical instructor and the athletic training students in clinical settings.

- Clinical Instructor (CI): An individual identified to provide supervision of athletic training students during their clinical experience (NATAEC, Retrieved September 1, 2007).

- Clinical Rotation: A specific guided clinical experience for the athletic training students through their athletic training educational process (college, high school, clinic, professional sports, etc).

- Clinical Site: The location in which an ACI or CI interacts with the ATS for clinical experiences (NATAEC, Retrieved September 1, 2007).
• Clinical Proficiencies: Evaluation tools used for evaluation of students’ integration of decision making skills and the critical thinking process (NATAEC, November 9, 2006).

• Computer simulation: A type of educational software wherein users learn concepts and skills by engaging in simulated activities on the computer. The abstraction or simplification of some real-life situation or process.

• Critical Thinking: “Purposeful regulatory judgment.” Critical thinking is the cognitive engine that drives problem solving and decision making (American Philosophical Association, 1990, as cited in The Delphi Report).

• Curriculum Program: A program that meets the guidelines and competencies established by the Commission on Accreditation of Athletic Training Education.

• Educational Competencies: The National Athletic Trainers’ Association has identified these competencies as necessary for effective performance as an entry-level certified athletic trainer (NATAEC, Retrieved September 1, 2007).

• Higher Education: Postsecondary institutions of education (colleges and/or universities).

• National Athletic Trainers’ Association (NATA): Governing organization for the athletic training profession.

• NATA Education Council (NATAEC): The council serves as the NATA’s voice in matters related to athletic training education. It facilitates continuous quality improvement in entry-level, graduate, and continuing athletic training education (NATAEC, Retrieved March 24, 2008).
• Role Delineation Study (RD): The established content areas for the BOC national certification examination. The RD identifies essential knowledge and skills for the athletic training profession and serves as a blueprint for exam development. The RD validates importance, criticality, and relevance to practice for both broad content areas and tasks (BOC, Retrieved January 19, 2008).

Summary

The implementation of computer simulations in medical education has dramatically increased during the last decade. The purpose of this study was to investigate if athletic training students performance on computer simulations on evaluation of athletic injuries reflect their critical thinking level. The secondary purpose of this study was to investigate whether using self-directed learning utilizing computer simulations over a four week period effects student performance on computer simulations related to the physical evaluation of athletic injuries. In the following section, each hypothesis is identified and analyzed for statistical significance. While this chapter summarized the background and purpose of this study, the following chapter provides a literature review used for justifying this study’s purpose, the instruments used, and the need for this study.
CHAPTER TWO: LITERATURE REVIEW

Introduction to the Literature

Technology is playing a prominent role in today’s education. The use of technology has increased dramatically in the last decade. It is becoming important for educational program administrators and faculty members to implement computer technology into their curriculum. Students attending higher education institutions today have varied exposure to technology, especially computers and the Internet. The integration of computer technology into the classroom is one way to keep students motivated to learn and assist them with their learning. The use of computer simulations as a teaching and self-directed learning method in education has been increasing. It is a goal of higher education to help students become critical thinkers and successful professionals. Important questions to ask are: 1) How is computer technology used in higher education? 2) How well is computer technology used in athletic training education? And 3) Does use of computer simulations help in improving and assessing athletic training students’ critical thinking?

This chapter reviews the literature regarding entry-level athletic training education and use of computer simulations as a learning and testing method. First, a brief review of athletic training education is provided. This is followed by a brief review of critical thinking and its use in higher education. Finally, a review of the use of computer simulation-based programs in the healthcare profession education is discussed.
Athletic Training Education

Athletic Training is an allied healthcare profession, recognized by American Medical Association (AMA) on June 22, 1990 (Delforge & Behnke, 1999). Certified Athletic Trainers (ATCs), professionals on the sports medicine team, have an in-depth knowledge of athletes’ medical histories, current health status and injury status for providing the necessary care to these individuals in possible catastrophic injuries. Certified Athletic Trainers are healthcare professionals who specialize in the prevention, diagnosis, treatment, and rehabilitation of sports injuries and illness.

As healthcare professionals make important decisions on a daily basis they need to be able to reflect on their work, patients, decisions, and their profession (Mishoe & Hernlen, 2005). This decision making is an aspect of critical thinking. By reflecting on previous experiences, they learn from previous mistakes and problems in the clinical environment (Mishoe & Hernlen, 2005).

Since June 30, 2006, all athletic training education programs (ATEPs) are required to be accredited by CAATE (CAATE, Retrieved June 28, 2008). Students in athletic training education programs must be exposed to educational competencies found in the NATA Athletic Training Educational Competencies Manual. These competencies are a compilation of cognitive and psychomotor competencies and clinical proficiencies and include measurable tasks (CAATE, Retrieved June 28, 2008). These clinical proficiencies have replaced the clinical hour requirements for eligibility for the BOC certification exam (Denegar & Hertel, 2002; Weidner & Henning, 2002).
Certified athletic trainers are assumed to practice with high levels of thought processes. Starkey (1997, p. 113) stated:

No other profession’s clinicians are responsible for preventing injury and illness, for evaluation/management, for rehabilitations, for counseling and for education of its clientele. We are the original multiskilled healthcare providers, although none of this knowledge or skill is unique to our profession.

The responsibilities of certified athletic trainers are increasing (Starkey, 1997). Athletic training educators’ job descriptions are ever-increasing as many teach and perform administrative duties, as well as provide care to athletes. This is similar to physicians working in teaching hospitals (Carr & Drummond, 2002).

Clinical Education

Athletic training students must be provided with sufficient time to learn, perform, and master clinical skills and proficiencies (Amato, Konin, & Brader, 2002; Miller & Berry, 2002). Proper demonstration and practice on models, classmates, and patients is necessary to allow students to see and execute procedures correctly. Furthermore, students must be afforded the opportunity to transfer their classroom and laboratory learning into clinical settings (Scully & Shepard, 1983; Starkey et al., 2004). As a part of athletic training education, students have to successfully complete educational competencies and clinical proficiencies. The clinical field experience environment must offer quality instruction and appropriate supervision, social support, and challenging clinical activities that allow students to remain engaged and use critical thinking.
Many factors influence clinical education. Weidner and Laurent (2001) organized clinical education settings standards that are considered practical, relevant, and suggestive of high-quality clinical education. These standards are presented in Table 1.
### Table 1

**Clinical-Education Settings Standards**

<table>
<thead>
<tr>
<th>Clinical-Education Settings</th>
<th>Clinical-Education Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Environment</td>
<td>Clinical education provides a stimulating environment for the learning.</td>
</tr>
<tr>
<td>Program Planning</td>
<td>Clinical education is structured to meet the objectives of the educational program and students.</td>
</tr>
<tr>
<td>Learning Experience</td>
<td>Clinical education settings provide learning experiences available to students.</td>
</tr>
<tr>
<td>Ethical Standards</td>
<td>The clinical instructors practice ethically and legally.</td>
</tr>
<tr>
<td>Administrative Support</td>
<td>Demonstrates administrative support of clinical education.</td>
</tr>
<tr>
<td>Effective Education</td>
<td>The clinical education settings must have effective and positive communication.</td>
</tr>
<tr>
<td>Staff Number</td>
<td>The clinical settings have an adequate number of clinical instructors to provide a good learning environment for students.</td>
</tr>
<tr>
<td>Setting Coordinator of Clinical Education</td>
<td>A clinical instructor who is responsible for coordinating the assignments and activities of the students at the clinical settings.</td>
</tr>
<tr>
<td>Clinical Instructor Selections</td>
<td>Clinical instructors must meet specific criteria.</td>
</tr>
<tr>
<td>Principles of Teaching and Learning</td>
<td>Clinical instructors apply teaching and learning principles to clinical education.</td>
</tr>
<tr>
<td>Professional Associations</td>
<td>Clinical instructors are interested and active in professional associations.</td>
</tr>
<tr>
<td>Adequate Space</td>
<td>Adequate space for learning, educational discussions and treatment of patients is available to students.</td>
</tr>
</tbody>
</table>
Throughout an athletic training student’s education, competencies must be evaluated and re-evaluated in order to provide entry-level professionals the chance to master the psychomotor skills necessary to their field. Clinical education should include knowledge-oriented activities on a regular basis, which will allow the clinical instructor both the necessary time and opportunities to evaluate students (Scully & Shepard, 1983).

According to Starkey et al. (2004), it is beneficial to students’ education to implement a descriptive clinical proficiency where students must analyze a problem, consider presented facts, and make appropriate decisions about the further evaluation of a patient’s condition. This approach to competency evaluation is more accurate and specific to athletic training than would be the use of a simple checklist for skills performance.

It also is important to evaluate athletic training students’ “learning over time” by assessing their ability to synthesize individual skills into larger-scale skill sets as they progress through their education in the classroom and clinical settings (Starkey et al., 2004). This type of assessment might be carried out by monitoring students’ performance on computer-simulated problem solving exercises and multiple-choice exams, as well as performance during hands-on clinical experiences. Peitzman, Nieman, & Gracely (1990) recommend using both computer simulation and higher-order multiple-choice questions to measure students’ “learning over time.”

**Athletic Training Students’ Clinical Supervision**

Every athletic training education program (ATEP) needs to have approved clinical instructors (ACIs) who educate and supervise athletic training students during
their clinical experiences. Clinical supervision includes constant visual and auditory interaction between athletic training students and ACIs (NATAEC, Retrieved November 9, 2006). Approved clinical instructors assist students in developing the critical thinking skills necessary to make appropriate healthcare decisions. They teach procedures, provide practice time, observe students, give feedback, and evaluate performance. Therefore, these individuals need to consider all available options and resources for presenting educational material to students (Laurent & Weidner, 2002). CAATE guidelines require certified athletic trainers to have a minimum of one year of experience to be able to serve as an approved clinical instructor and are required to participate in an approved clinical instructors’ workshop before serving in such a capacity (Foster & Leslie, 1992).

Approved clinical instructors are considered content experts in athletic training. They need to be able to ask questions that target higher-level thinking and that push students toward the upper echelon of the cognitive processing continuum (Boney & Beker, 1997; Irby, 1986; Starkey, Koehneke, Sedory, & Turocy, 2001; Starkey et al., 2004). By modeling professional and ethical behavior, ACIs can assist in influencing athletic training students by mentoring, nurturing, modeling leadership style, and sharing their own experiences (Starkey, 2002). The development of athletic training students can be affected either positively or negatively as a result of this influence (Curtis, Helion, & Domsohn, 1998).

According to Palmer (2002), athletic training students benefit from a variety of teaching techniques, including the physical performance of skills, to promote critical thinking and decision making skills, and providing appropriate feedback. Furthermore,
athletic training students find a positive, relaxed, open, and family-like atmosphere to be the most influential factor of clinical instruction, followed by clinical instructors interacting with students in an ethically appropriate, personal, and professional manner (Palmer, 2002).

In 2002, Miller and Berry looked at clinical education from four different points of view while videotaping 20 athletic training students during their clinical rotations. They divided the time athletic training students spent in clinical settings into instructional time, clinical time, managerial time, and unengaged time. Students spent 59% of their clinical education time unengaged, 30% of their time in active learning, and the remaining 11% of their time on managerial skills. Seniors spent more time in “engaged” activities than juniors and sophomores. This was due both to their level of education and to their confidence in performing most of the athletic training duties. However, junior- and senior-level students were not as involved in instructional time as they should have been. It is the clinical supervisors’ responsibility to spend more time teaching, supervising, and sharing experiences with their students in order to help students both increase their knowledge and gain the self-confidence necessary for working with patients (Miller & Berry, 2002).

In 2004, Berry, Miller, and Berry further investigated clinical experience. This study investigated active learning time that was calculated as both clinical and instructional time together. They found different results than those found by Miller and Berry in 2002. The investigators calculated the percentage of active learning time by dividing it by the total opportunity time, and their results suggested that students were
engaged in active learning only 51% of the time, and 17% of the time were unengaged. This may suggest that only a limited amount of time is used for active learning during students’ clinical experiences (Berry, Miller, & Berry, 2004).

Pipkin (2001) investigated practices in athletic training clinical education among NCAA institutions. Based on her data, 84% of participating head athletic trainers reported that class rank played an important role in supervision. Indeed, Pipkin’s data revealed a linear relationship between the class level and percentage of time spent in direct clinical supervision. Freshmen received the most direct clinical supervision, while sophomores, juniors, and seniors were provided with gradually less direct clinical supervision. Seniors were given more supervised field experience, while freshmen were given more direct clinical supervision and less supervised field experience (Pipkin, 2001). With the varying research presented, it is important for ACIs to be consistent in providing appropriate supervision and engaging critical thinking and decision-making with all academic levels of athletic training students. Do the ACIs have content expertise, technology and time to sufficiently engage successful active learning in athletic training students?

**Educational Competencies and Proficiencies**

Certified athletic trainers no longer are expected to specialize only in orthopedic or athletic injuries and conditions. Rather, they are expected to be competent with diagnosing common diseases and illnesses by their signs and symptoms (McGee 2003). Certified athletic trainers must be able to recognize, analyze, and interpret various components of each patient’s unique healthcare issues (McGee, 2003). Certified athletic
trainers do not work only with athletic injuries, and may work with patients affected by illnesses and conditions such as pregnancy, HIV infection, hypertension, viral and bacterial infections, or heart conditions and diseases (McGee, 2003). Therefore, athletic training students should be given sufficient time to learn, perform, and master clinical skills and proficiencies (Amato et al., 2002; Miller & Berry, 2002). Students need the opportunity to transfer their classroom and laboratory learning into clinical settings (Starkey et al., 2004).

As a part of athletic training education, students have to complete and succeed in educational competencies and clinical proficiencies. Composed of cognitive and psychomotor competencies, clinical proficiencies define a common set of skills required of entry-level athletic trainers (NATAEC, Retrieved November 9, 2006; NATAEC Retrieved September 1, 2007). The cognitive competencies evaluate students’ understanding of the science, theory, and techniques related to the proficiency, whereas students’ skills performance is a part of psychomotor skills assessment (Heinrichs, 2002; Starkey et al., 2004).

The competencies prepare certified athletic trainers to handle the general aspects of healthcare (McGee, 2003). These competencies are to be evaluated and re-evaluated to allow students the opportunities to master the psychomotor skills. This would include the clinical assessment of individual skills performance (Starkey et al., 2004).

**Critical Thinking**

Education is a dynamic process involving cognitive, affective, and psychomotor development (Bloom, 1956). Cognitive development is initiated by simple recall of facts
through the increasingly more complex and abstract mental levels of higher order thinking (Bloom, 1956). In developing these components, one begins to apply critical thinking skills.

Although critical thinking can be traced back to the work of ancient philosophers such as Aristotle, it was first brought to educators’ attention by John Dewey, and has been an important part of higher education for the last two decades (Leaver-Dunn, Harrelson, Martin, & Wyatt, 2002). Universities and colleges revised their general education curricula to include inductive thinking and inquiry-oriented strategies (Darling-Hammond, 1993). Based on Ratcliff, Johnson, La Nasa & Gaff’s (2001) national survey, 72% of the national colleges and universities surveyed identified critical thinking as an important “cognitive area” of general education.

**Critical Thinking Definitions**

No critical thinking standards exist, and therefore various definitions of the term are found (Gellin, 2003). Critical thinking (CT) is composed of attitudes, knowledge, and skills, and can be influenced by gender, religion, age, ethnicity, and socioeconomic status (Daly, 1995; Watson & Glaser, 1980). Healthcare professionals make important decisions on a daily basis, and so they need to be able to reflect on their work, their patients, their decisions, and their profession (Mishoe & Hernlen, 2005). They have to decide what to believe and what to do by reflecting on previous experiences in clinical environments (Mishoe & Hernlen, 2005).

CT requires thinking skills as well as an inclination to engage in the learning process. In order to engage effectively in critical thinking, one must develop the
appropriate skills. Critical thinking is an intellectual process that requires one to actively conceptualize, apply, synthesize, and analyze gathered information (Paul, 1993).

According to Brookfield (1987), students begin to understand the critical thinking process by identifying and challenging assumptions, by challenging the importance of context, by imagining and exploring alternatives, and by using information for reflective skepticism.

Dewey defined critical thinking, or, as he referred to it, “reflective thinking” as active, persistent, and careful consideration of any belief or form of knowledge supporting further conclusion to which it tends (Dewey, 1933). Dewey (1933) developed a critical thinking model that he referred to as the “reflective thought model.” This model included a five-stage process: suggestions, problem definition, hypothesis generation, reasoning, and hypothesis testing. Several individuals have used Dewey’s original model as a basis for new critical thinking models.

Garrison (1991) incorporated Dewey’s hypothesis and Brookfield’s five-phase critical thinking model in order to identify the following five stages of critical thinking: problem identification, problem definition, exploration, applicability, and integration. These five stages are considered to be cyclical in nature rather than linear (Garrison, 1991). When students complete a part of a problem with which they are presented and receive new information, they start a new cycle of evaluating the specific problem (Garrison, 1991). This might be referred to as a self-guided reflective cycle. Garrison (1991) stated that creative thinking allows students to sense difficulties and problems.

Bensley (1998) stated that CT is reflective thinking involving the evaluation of evidence necessary for conclusion. Thus, it is necessary to provide quality evidence for
students. Bensley listed four specific characteristics that individuals must possess in order to develop an understanding of the critical thinking process. These characteristics include: knowledge of reasoning, cognitive skills involved in reasoning, knowledge that is relevant to the problem, and a set of dispositions to think critically. To develop good critical thinking skills, one must be able to use critical reflection. Critical reflection is important because it facilitates one gaining an understanding of one’s own perception of the situation (Ford & Profetto-McGrath, 1994).

**Critical Thinking in Higher Education**

One of the main goals of educators in higher education is to teach students to think better than they did when they began attending their college or university of choice (Pithers & Soden, 2000; Walkner & Finney, 1999; Williams, Wise, & West, 2001). However, evidence suggests there is limited critical thinking development in college classrooms (Tsui, 2001). Browne and Freeman (2000) believe that “current pedagogical habits are not optimal for the development of critical thinking” (p. 305).

According to Tsui (1999), critical thinking is influenced by course content as well as by instructional technique. Classroom experience has the largest impact on students’ critical thinking abilities (Tsui, 1999). For critical thinking to take place in the classroom, students must be able to both comprehend the information provided and reason out their decisions. Questions guiding students towards the correct conclusion to a problem and the proper reasoning behind an argument are vital for critical thinking to take place (Browne & Freeman, 2000). Instructors help students to reinforce critical thinking by systematically asking “Why?” (Browne & Freeman, 2000).
Active learning is very important for critical thinking to take place (Browne & Freeman, 2000). Active learning, as Browne and Freeman (2000) define it, is the asking and answering of critical questions, and as such, it needs to be encouraged by classroom instructors. Lectures need to require reflection upon and integration of the material covered in order to promote critical thinking (Browne & Freeman, 2000). Browne and Freeman (2000) concluded that critical thinking can be taught in higher education with the active assistance of the students.

Clearly, it is necessary for students to be able to assess the correct answer to any given problem. However, it is even more important that students be able to evaluate the thinking process behind that answer (Pithers & Soden, 2000). During classroom discussions, students articulate and apply course material, and thereby they develop and attach a specific association to the material being discussed (Browne & Freeman, 2000). Students also present their ideas related to course material during classroom discussions, and these ideas become more meaningful to students as a result of the synthesizing and critical thinking required of them before they might present their ideas to the class (Browne & Freeman, 2000). If conflicts do not arise during classroom discussions, however, students rely upon arguments that support their current beliefs, and as a result the development of critical thinking is affected negatively (Browne & Freeman, 2000).

Another way to promote critical thinking in higher education is via service learning. During service learning, students both apply and improve upon their communication skills, critical thinking abilities, civic responsibility, and their sense of caring for others (Sedlak, Hoheny, Panthofer, & Anaya, 2003). Based on Sedlak et al.

Another aspect of positively effecting students’ development of critical thinking is through writing assignments returned with instructors’ feedback, research projects, classroom presentations, and essay exams (Tsui, 1999). These types of assignments not only challenge students to construct a response, but also allow them to employ their memorization, recognition, and selection skills (Tsui, 1999). Based on Tsui’s (1999) research, courses in which instructors emphasized problem solving and/or critical thinking allowed students greater gains in their critical thinking abilities than courses in which instructors employed traditional teaching methods. Using only multiple-choice exams limits an educator’s capability to test students’ critical thinking skills (Tsui, 1999).

Problem solving models involve evaluation and understanding of the problem or situation (Bernstein, 1995; Pithers & Soden, 2000). Students are able to examine any given problem in a systematic way, and therefore, are able to construct a better understanding than they would from a single argument (Bernstein, 1995). Writing is an important part of the promotion of critical thinking. Writing promotes self-reflection and also allows time for reflection and consideration of other points of view (Wade, 1995). Written assignments, as opposed to classroom discussions, guarantee the participation of all students, even those who might limit their oral expression during classroom sessions (Wade, 1995). Furthermore, during written assignments, instructors can encourage students to argue from both sides of an issue. The ability to encourage students in this manner is missing during the oral discussion because most students will argue only in
support of their own beliefs and will see only their own side of the problem (Wade, 1995). Wade (1995) argues that classroom discussions rewarding in the form of attention may not be suitable for all students.

Many higher education curriculums use case studies to promote critical thinking (McDade, 1995). A case study is a written description of a problem presented for analysis. Each case study is created for a specific purpose and supports intensive discussion and analysis (McDade, 1995). Presenting a case study is a unique teaching method. Students analyze the case study and follow up with a discussion and presentation of objective facts (McDade, 1995). It is necessary that teachers are prepared for the case study presentation. This type of preparation is different than the preparation required for a regular lecture, in which teachers commonly prepare an outline of statements. For case study presentation, teachers need to prepare an outline of questions for discussion as well as prepare to lead their students through analysis and application (McDade, 1995).

During traditional lecture, students often view their instructor as a problem solver of the presented problem and presents his or her point of view. In this situation, students are not exposed to the many diverse ideas that were involved in the instructor’s process of determining the ultimate resolution (Cooper, 1995). Students copy the end of the process without getting into deeper analysis of the problem (Cooper, 1995).

According to Hager, Sleet, Logan, & Hooper (2003), undergraduate students in science classes are expected to solve closed problems with unique answers where the data needed to solve the problem is provided. This approach permits students to solve the problem by applying familiar rules or procedures instead of using critical thinking. These
types of assignments, therefore, allow students to think there is a unique answer to every problem (Hager et al., 2003). By designing problems that are more open, and that have unfamiliar solutions, educators encourage students to use a wider range of abilities when determining solutions (Hager et al., 2003).

Good thinkers are good questioners (King, 1995). She defines good thinkers as students who constantly analyze, puzzle over significance, search for explanations, and debate between new experiences and what they already know. Good thinkers constantly are asking questions such as What does it mean?, What is the nature of this?, and Why is this happening?. Classroom experiences promote critical thinking when provoking questions are presented to students (King, 1995). Provoking questions need to be a part of higher education in order to promote critical thinking, as provoking questions facilitate critical thinking in the responder as well as in the asker. Asking provoking questions induces the analysis of ideas, comparison, inference, prediction, and evaluation (King, 1995).

There is no one general way to teach critical thinking. It depends on the program goals and the content to be taught (Pithers & Soden, 2000). It is difficult to facilitate deep thinking when a problem has no significant application to a particular discipline, and students’ cognitive abilities are varied (Pithers & Soden, 2000). Broad forms of thinking do not have to be learned from scratch each time a student is involved in learning in another discipline (Pithers & Soden, 2000). Many students do not recognize the involvement of critical thinking in courses outside of their own discipline, which could be since students will not be professionals in these outside disciplines; they learn classroom
material in terms of the facts presented and accept these facts without further questioning (Tapper, 2004). However, many universities include in their curriculums specific general classes that are meant to enhance students’ abilities to think critically (Tsui, 1999). Pithers and Soden (2000) believe that critical thinking can be developed more effectively in a student’s specific subject matter than in general courses.

“Deference to critical thinking as an educational objective is certainly more common than the actual encouragement of critical thinking in university classrooms” (Browne & Freeman, 2000, p. 301). Students’ participation and faculty encouragement are positively related to critical thinking (Gibbs, 1988). Gibbs (1988) stated that the development of programs that utilize critical thinking requires the faculty to have specific learning goals and objectives, and that the faculty should be given a release time to achieve these goals. According to Gibbs (1988), it is difficult to bridge the gap between faculty members’ intentions for teaching critical thinking and their behavior regarding critical thinking. In order to be effective in teaching critical thinking, it is necessary for faculty members to be involved in critical reading, preparing critical thinking lesson plans, and collecting materials (Gibbs, 1988).

Faculty members often see conflict between covering the content material and covering critical thinking as a pedagogical goal, and in most situations many faculty members choose covering content material over critical thinking (Gibbs, 1988). Instructors in higher-level education should intentionally stimulate controversy in their classrooms (Browne & Freeman, 2000). This controversy creates discomfort for the students and causes intellectual uneasiness, which in turn promotes critical thinking.
Thinking begins only when a state of doubt of what to do or what to believe exists (Browne & Freeman, 2000). If instructors promote an atmosphere of reflection and rejection through reasoned judgment, students’ critical thinking skills are improved upon, and thereafter students do not just blindly accept what is presented to them (Browne & Freeman, 2000). According to Giancarlo & Facione (2001), educators must commit to improving students’ cognitive skills along with dispositions towards critical thinking. By doing so, educators promote critical thinking by giving students opportunities to use critical thinking while solving problems (Giancarlo & Facione, 2001).

Critical thinking is an individual process, and as such, educators only can facilitate it. Students must learn to teach themselves to reflect upon and to refine their problem solving strategies. Students also must work on developing metacognitive knowledge and skills (Pithers & Soden, 2000). Teachers in higher education are subject experts, and their students are seeking that level of knowledge. The experts with the knowledge speak, and the students seeking the knowledge listen. During this process, students often are passive learners (Browne & Freeman, 2000). Instructors who promote critical reflection allow students to assume a role of active partnership in the learning process (Walkner & Finney, 1999). It is crucial for educators to ensure the transfer of students’ knowledge and skills from one subject to another, which may be done by offering students frequent opportunities to practice using critical thinking skills (Browne & Freeman, 2000). Students have to see how the material learned in one context relates to another (Tapper, 2004). Educators can promote the development of students’ critical
thinking by teaching them both to ask critical questions and generate their own relevant critical thinking questioning (King, 1995).

Educators assess students’ thinking through dialogue and through presenting a systematic series of questions (Pithers & Soden, 2000). When students cannot make reasonable responses to such questions, educators need to guide them in order to help them to understand why those questions are problematic (Pithers & Soden, 2000). Lauer (2005, p.35) stated: “We [educators] should use critically thinking pedagogy to teach content as well as teach students how to simply think critically.”

Faculty members’ attitudes towards teaching also play an important role in undergraduate education. To enhance critical thinking, it is important for educators to believe in their students’ abilities to grasp higher-level thinking (Tsui, 2001). Based on research institutions where faculty members usually are disappointed with their students’ poor academic achievement, students are restricted from opportunities to practice and improve upon their critical thinking skills (Tsui, 2001). On the other hand, in research institutions where faculty members are both confident in their students and enthusiastic about teaching, students are challenged in creativity and experimentation, and thereby critical thinking is promoted. Faculty members need to perceive teaching as a mutual learning experience where students are a part of their own education and are supportive of faculty efforts. It is also important for faculty members to pursue the facilitation of critical thinking as a team project and to work collectively to achieve this goal (Tsui, 2001). During the promotion of critical thinking, teachers need to be receptive to new
ideas. They also need to be involved more as facilitators than as instructors (Pithers & Soden, 2000)

When critical thinking is promoted during higher education, it is important that all tests, assignments, and final assessment tools reflect critical thinking (King, 1995). All assessment assignments should evaluate students’ understanding of the material and not just students’ ability to recall memorized information (King, 1995). A student’s disposition towards critical thinking is not reflected in his or her assigned grade (Giancarlo & Facione, 2001). However, there is a difference between a student’s disposition towards critical thinking and that student’s critical thinking skills (Giancarlo & Facione, 2001). Table 2 summarizes possible ways to promote critical thinking in higher education.
<table>
<thead>
<tr>
<th>Educational Tools</th>
<th>Critical Thinking</th>
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</table>
| Classroom Discussions                   | Evaluation of thinking process behind answers  
Articulation and application of course material  
Development of specific association to the material being discussed  
Reflection upon and integration of the material |
| Service Learning                        | Application and improvement of communication skills, civic responsibility, and critical thinking.  
Increase of self-confidence, self-reflection, and self-esteem |
| Writing Assignments With Instructors’ Feedback | Construction of a response, employ memorization, recognition, self-reflection, consideration of other points of view, and asking deep level questions:  
*What does it mean?  What is the nature of this?  Why is this happening?* |
| Intentional Controversy in the Classroom | Creation of discomfort and intellectual uneasiness – promoting critical thinking, active learning, asking and answering critical questions. |
| Interactive Simulations                 | Application of knowledge to practice  
Building upon prior knowledge  
Assessing a real problem |
| Computer Technology                     | Increase motivation to learn  
Promote analysis, interpretation and reasoning  
Increase computer skills |
| Problem-based Learning                  | Promote investigation of a problem  
Increase problem solving and decision making skills  
Facilitate critical thinking  
Promote self-directed learning and problem solving |
| Case Studies (computer)                 | Promote problem solving, systematicity, self-confidence, truth seeking, analyicy, and critical reflection |
Teaching Critical Thinking

Watson and Glaser (1980) defined critical thinking as a combination of attitudes, knowledge and skills. The two developed the Watson-Glaser Critical Thinking Appraisal (WGCTA) in 1964, and added modifications to this instrument in 1980. This instrument includes five subtests that measure the following: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments (Watson & Glaser, 1980).

Inference refers to the ability to discriminate between true and false information, whereas recognition of assumptions relates to the ability to recognize unstated presuppositions in provided statements. Deduction is the ability to recognize whether a conclusion is made from given feedback, and interpretation is a critical thinker’s way to weigh the evidence and decide what to do. Evaluation of arguments presents the ability to differentiate between strong relevant arguments and those that are weak and irrelevant to a particular issue (Watson & Glaser, 1980).

It is the goal of education to help students to develop and to support critical thinking. Teaching CT is difficult because it is an abstract skill rather than a skill based upon clear-cut procedures (Brooks & Shepard, 1990). Some studies suggest that critical thinking improves over time (Angel, Duffey, & Belyea, 2000; Pepa, Brown, & Alverson, 1997). Goodfellow’s (2001) study supports the idea that critical thinking requires prior experience, as prior experience is necessary in order for one to be considerate and reflective.

Many healthcare educators use computer simulations to provide students with opportunities to apply and integrate knowledge, skills, and critical thinking (Rauen,
Cole and Ramirez (2000) used clinical case scenarios to evaluate the critical thinking abilities of applicants to an emergency nurse practitioner master program. They found a high correlation between grade point average (GPA), Miller Analogy Test (MAT), or Graduate Record Examination (GRE) scores and clinical case scenario performance with successful completion of the program.

Educators need to aid students in developing critical thinking skills in all academic settings early on, as doing so will enhance a student’s ability to resolve issues through critical thinking. Many medical schools adopt problem-based learning because its methods are designed to promote critical analysis skills, self-directed learning, and the problem solving processes practiced by physicians (Barrows, 1990). Frost (1996) stated that problem-based learning helps healthcare professionals devise solutions highly relevant to healthcare practice.

Problem-based learning (PBL) is a teaching and learning method that facilitates critical thinking and clinical decision making (Mishoe & Hernlen, 2005). PBL fosters the development and growth of critical thinking and critical reflection (Maudsley & Strivens, 2000; Williams, 2004). In PBL, classroom material is presented to students via problems carefully designed to challenge students to both discover and accomplish the objectives of a particular curriculum (Celia & Gordon, 2001).

Tiwari, Lai, So, and Yuen (2006) conducted a three-year study comparing the effects of PBL versus lecturing on students’ critical thinking development. The authors concluded that the PBL students demonstrated significantly greater improvement in truth-seeking, analyticity, systematicity, critical thinking, and self-confidence as compared
with the lecture students. The PBL students were encouraged to analyze problems through initiation and the development of appropriate investigations. They had to test newly acquired knowledge in relation to the problem (Tiwari et al., 2006).

Hindrances to critical thinking or its development can include students’ resistance to active learning, possible impediments to thinking critically, inadequate class time, insufficient time to prepare critical thinking activities, and pressure on instructors to cover material in quantity (Gibbs, 1988). Faculty members are under constant pressure to cover content in a limited amount of time, and so the lecture is the most commonly used teaching method (Walsh & Seldomridge, 2006). Besides educating athletic training students, athletic training faculty members are required to maintain athletic training program accreditation, provide healthcare, and maintain faculty requirements including scholarship. These responsibilities may usurp the time needed to prepare the appropriate content for teaching critical thinking. Teaching during the morning, spending the whole afternoon in the athletic training room providing medical services to athletes and clinical education to athletic training students, and then performing research places great pressure on athletic training educators’ shoulders.

Kowalski and Louis (2000) conducted a study investigating whether nurses participating in computer simulation technology activities achieved higher-level critical thinking than nurses learning in a traditional classroom environment. Their instrument measured students’ abilities to analyze, interpret, and reason computer simulated scenarios. The authors concluded that students who participated in computer technology activities scored significantly higher than students in the control group. The use of
computer simulation increased students’ responsibility, communication, and participation. Students also improved their computer skills (Kowalski & Louis, 2000). This method may both decrease the amount of teacher preparation time needed to teach critical thinking and assist students in learning and understanding how to think critically.

In today’s education, computer technology is available for faculty use allowing them to incorporate slides with powerful graphics and animations in their classrooms. This enables faculty members to make their lectures entertaining and interesting to students. However, the faculty still does the majority of the work, and students remain passive learners (Walsh & Seldomridge, 2006).

**Critical Thinking in Athletic Training Education**

It is important for healthcare professionals to develop critical thinking (CT) abilities for diagnostic accuracy. Critical thinking is a beneficial skill to healthcare professionals and their patients (Rauen, 2001). These professionals must be able to derive clinical inferences from provided information, weigh the evidence, make assumptions, and distinguish between weak and strong arguments (Miller, 1992). CT is focused on deciding what to believe or do, thinking about thinking while thinking, making the thinking process better with a purpose, and self-regulatory judgment (Ennis, 1985; Facione, 1990b). Thus, the main goal of healthcare education, including athletic training education, is to help students become critical thinkers (Starkey et al., 2004). It is vital to evaluate students’ performance in solving problems and to put less emphasis on simply identifying the correct answer (Miller, 1992).
As compared to novices, more experienced learners use different techniques to collect and analyze new information (Tichenor, Davidson, & Jensen, 1995). Athletic training students have to learn basic factual knowledge in lower-level classes and during their first clinical rotations. At this point in their education, beginner students use lower-level thinking and practice less critical thinking than upperclassmen. As athletic training students progress through their athletic training education program, they should be given more responsibility and independence as this approach promotes critical thinking (Fuller, 1997).

In 2004, Stecyk investigated the correlation between athletic training students’ critical thinking abilities, institutional control, and athletic competition level. A significant positive correlation between the number of faculty members and students’ ability to think critically was reported. Therefore, students benefit from exposure to different teaching and learning styles, thought processes, and athletic training skills. They need to use critical thinking to evaluate each learning method and then decide which one they will use in any given situation (Stecyk, 2004).

As critical thinking includes problem solving and decision making, however, it is very difficult to teach and/or evaluate during a traditional lecture (Heinrichs, 2002). Examination questions that require critical thinking not only are difficult to write, but also are time consuming to evaluate (Miller, Sadler, Mohl, & Melchiodi, 1991). Overall, written and practical examinations do not provide appropriate evaluation of students’ critical thinking abilities, progress, or understanding of classroom material (Fuller, 1997; Heinrichs, 2002). The ability to evaluate whether or not a student knows why an answer
is correct, and/or knows other alternative correct answers is missing from the written examination. Therefore, for the student, the motivation for seeking the truth is limited, and consequently, students often are passive learners (Colussiello, 1997; Fuller 1997; Heinrichs, 2002). Because students are now being tested on their ability to think critically in the hybrid portion of the BOC examination, athletic training educators should undergo specific training. This training may help them become more effective educators in writing educational objectives that promote critical thinking, use higher-level examinations to promote students’ thinking in higher level courses, and limit multiple-choice questions on examinations to eliminate cueing (Fuller, 1995).

**Problem-Based Learning in Athletic Training Education**

Fortunately, today’s higher education is leaning away from the traditional student-centered passive learning and moving towards active learning where students talk and listen, write, reflect, complete activities in groups, complete simulations, undertake case studies, and participate in role playing (Heinrichs, 2002). Problem solving through case study is the approach that has been used the longest to promote the decision making process (Heinrichs, 2002). Students find the use of case injury scenarios beneficial because it increases their motivation level and enables them to incorporate their athletic training knowledge. Athletic training students and athletic training instructors find the use of case studies beneficial because it makes the educational process more meaningful to the student. Thus, computer simulations using case injury scenarios offer students a stronger athletic training education (Mensch & Ennis, 2002).
Problem-based learning is a method used to promote critical thinking and problem solving. During PBL, students research and investigate problems more in depth, which makes them more active and responsible learners (McGee, 2003). PBL helps students to become critical thinkers by teaching them how to reason their way through clinical problems (Heinrichs, 2002).

There are many benefits to problem-based learning in athletic training education. These benefits include 1) helping students to become critical thinkers, 2) reasoning their way through their clinical problems, 3) recognizing when more education is needed to be able to complete required tasks, and 4) being able to learn information as they go through different clinical problems (Heinrichs, 2002).

Athletic trainers use psychomotor skills and decision making processes simultaneously while managing a medical situation. These two elements, however, require separate thought processes. Problem-based learning is able to put these elements together, and thus should be a vital part of athletic training education (Heinrichs, 2002). Additionally, it is important for athletic trainers to be able to use available resources, communicate well, and work as a part of a team. All of these characteristics too can successfully be promoted through the use of PBL (Heinrichs, 2002).

**Athletic Training Clinical Experience and Critical Thinking**

Critical thinking builds the foundation for clinical decision making, and it assists students and healthcare professionals in thinking beyond the routines and recommended protocols (Erickson-Owens & Powell-Kennedy, 2001). According to Starkey et al. (2004), hands-on clinical education is beneficial to students because it helps them not
only to improve their critical thinking skills but also to develop their own personal roles and identities. While critical thinking is used both outside and inside of the clinical settings, however, clinical reasoning only is used in clinical environments (Alfaro-LeFevre, 2004). Clinical thinking involves clinical judgment and decision making based on both solid theoretical knowledge and the ability to notice clinical signs and symptoms, interpret what has been observed, and take appropriate actions with follow-up reflection (Alfaro-LeFevre, 2004).

The clinical area should be the area where healthcare students fine-tune their critical thinking skills as they are learning to provide healthcare (Walsh & Seldomridge, 2006). Students need to be motivated to demonstrate their critical thinking skills while in the clinical setting. They need to be motivated to seek the truth and to be inquisitive (Facione & Facione, 1994a). However, according to Keeley and Brown (1986), there have been notable problems with students’ ability to apply their critical thinking skills to real-life practice. Because instruments that measure critical thinking ability do not specifically assess clinicians’ disposition to think critically, Mishoe and Hernlen (2005) recommended the use of a variety of different instruments and evaluation strategies for comprehensive critical thinking assessment in healthcare education.

**Problem Solving, Insight, Activity and Simulation Use**

One of the main supporters of the Problem Solving Theory was John Dewey. Dewey stated that thinking is initiated by the learner’s interest in solving the problem (Phillips & Soltis, 2004). The learner has to be physically and mentally active and engaged in the problem (Phillips & Soltis, 2004). Dewey stressed that problems to be
solved must pertain to learners’ interests and experiences. When a learner is presented with new information, his or her brain will search its memory, trying to relate the new information to past experience. A learner has to struggle personally with the problem in order to learn how to solve it. If he or she is not personally involved, the learning process follows the mechanical method that Dewey called “static, cold storage” knowledge (Phillips & Soltis, 2004).

Justification for learning from simulation is provided when one considers the fact that by making students active learners, educators encourage students’ motivation towards problem solving. By making decisions on their own and based on the consequences, students learn to view material more critically than they would if they simply follow and accept decisions made by others (Bernstein, Scheerhorn & Ritter, 2002). During simulations, learners apply knowledge to practice. Simulation is consistent with the cognitive learning theory because it is interactive, builds upon prior knowledge, and relates to a real problem. The objectives for simulation must be similar to the objectives of the learner (Davies, 2002). “To a large extent, the learner is forced into a particular behavior by the simulation they are manipulating” (Davies, 2002, p. 279).

Solving a problem through simulation may be much less complex than solving the same problem in the “real world.” However, simulation can help to improve a learner’s awareness of the steps necessary to solving a problem. The student who solves a problem through simulation has a chance to master the skills needed to solve that problem prior to facing the problem in a real-life situation (Bernstein et al., 2002). Mastering some of these skills might be difficult, sometimes even impossible, in the “real world.” Thus,
using a simulation is beneficial to both learning and confidence building in students. Simulations allow students to learn from harmless, self-generated feedback. The main advantage of using games and simulations in the classroom is that students are forced to actively participate. Passive observation is limited in this learning model. The students are presented with a problem, and they have to make decisions, solve the problem, and react based on the results of their decisions. They learn from the consequences. Simulations have a positive effect on learners’ motivation (Bernstein et al., 2002). “Simulations can build an environment from which students can learn experientially. Therefore, students analyze situations from the inside, or the position of a participant” (Bernstein et al., 2002, p. 10).

**Instruments Measuring College Students’ Critical Thinking**

Several general instruments have been developed to measure critical thinking in college students (Giancarlo & Facione, 2001; Mishoe & Hernlen, 2005). Each of these instruments has its own unique strengths and weaknesses. The most frequently used are The Watson-Glaser Critical Thinking Appraisal (WGCTA), the California Critical Thinking Disposition Inventory (CCTDI), and the California Critical Thinking Skills Test (CCTST) (Walsh & Seldomridge, 2006).

The California Critical Thinking Skills Test (CCTST) and Watson Glaser Critical Thinking Appraisal (WGCTA) are two primary instruments used in research that assess critical thinking abilities of college-age students (Adams, Stover, & Whitlow, 1999). Adams et al. (1999) evaluated prior research and stated that the CCTST reflects critical thinking abilities in allied health professions more accurately than does the WGCTA.
Further current research states these are good critical thinking assessment tools (Staib, 2003). Although it is impossible to obtain direct measurement of critical thinking based on these tests, it is possible to evaluate critical thinking ability from these self-report assessments (Bers, 2005).

Watson and Glaser (1980) defined critical thinking as a combination of attitudes, knowledge and skills. The WGCTA was developed in 1964 with later modifications in 1980. The WGCTA includes five subtests measuring inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments (Watson & Glaser, 1980). The ability to discriminate between true and false information is referred to as inference. Recognition of assumptions relates to the ability to recognize unstated presuppositions in provided statements. Deduction refers to the ability to recognize whether the conclusion made followed from given statement (Watson & Glaser, 1980). Critical thinkers need to be able to weigh the evidence and decide about the conclusion, is referred to as interpretation. Finally, critical thinkers have to be able to evaluate the arguments related to the problem (Watson & Glaser, 1980). Scott, Market, and Dunn (1998) examined changes in WGCTA scores of medical students from each student’s entry into a program until the end of each student’s third year. According to the collected data, WGCTA scores improved significantly. The authors also concluded that students’ WGCTA scores were modestly correlated with their scores on the US Medical Licensing Examination. Miller, Sadler, and Mohl (1993) found WGCTA scores to be predictive of success in preclinical courses.
Facione and Facione (1994a) defined critical thinkers as students with purposeful, self-regulatory judgment and interactive, reflective reasoning. In 1992, Facione and Facione developed the California Critical Thinking Disposition Inventory (CCTDI) to measure dispositions toward critical thinking. This instrument measures one’s intellectual curiosity and desire for learning. In 1994, Facione and Facione developed the California Critical Thinking Skills Test with the intention of measuring CT based on their definition. The CCTST is intended to measure analysis, evaluation, inference, and deductive and inductive reasoning (Facione & Facione, 1994b). Students’ comprehension of the material or significance of experiences and identification of relationships among statements, questions, and opinions is measured. The evaluation items measure a student’s ability to assess both the credibility of material and the relationship between statements (Facione & Facione, 1994b). The CCTST provides a total score and a norm-group percentile. It also compares the student’s score to other four-year college students’ scores and provides subscale scores for deductive and inductive reasoning (Bers, 2005).

In deductive reasoning, conclusions are drawn from the general to the specific, and in inductive reasoning conclusions are drawn from the specific to the general.

**Use of Computer Technology**

*Computer Use in Higher Education*

Educators use the Internet, computer discussion boards, Blackboard, computer case studies, PowerPoint, educational websites and other computer software and websites to supplement traditional lecture education. Computer assisted instruction is an instructional method used in education to facilitate the learning process (Calderone,
One type of computer assisted instruction, web-based learning, utilizes individualized instruction to deliver educational material via either the Internet or intranet computer networks (Manochehri & Young, 2006).

Manochehri and Young (2006) investigated the relationship between web-based learning and learning styles using Kolb’s Learning Style Inventory (LSI). LSI divides people into four categories based on their preferred way of learning. These categories are: accommodators, convergers, assimilators, and divergers. Accommodators prefer concrete experience (CE) and active experimentation (AE). They take risks and learn by a trial-and-error problem solving approach. Accommodators learn the best by doing and feeling (Kolb, Boyatzis, & Mainemelis, 1999). For assimilators who are classified as watchers and thinkers, abstract conceptualization (AC) for inputting of information and reflective observation (RO) for processing of information are the most suitable learning methods (Kolb et al., 1999). These types of learners prefer to learn via considering abstracts and then observing their possible role in the real world. Converger learners learn through AC for inputting of information followed by AE for processing information (Kolb et al., 1999). Convergers prefer to learn by considering abstract concepts and then actively experimenting with them. They are referred to as thinkers and doers, and are good at solving specific problems with a single correct answer (Kolb et al., 1999). Diversers are feelers and watchers. They learn the best through CE for inputting of information and RO for processing of information (Kolb et al., 1999). Diversers prefer to learn by observing concrete examples and then reflecting on their observation. They learn by watching and doing, and they represent a concrete-reflective learning style (Kolb et al., 1999). Based
on Manochehri & Young’s (2006) investigation of web-based learning, assimilators and convergers did better with the web-based learning method than did divergers and accommodators, whose performance was better after instructor-based learning.

*The Use of Computer Simulation Problem-Based Programs in Healthcare Profession Education*

There has been a large increase in the diversity of today’s education, which puts an increased workload on educators (Jeffries, 2001). Computer simulations, by accommodating diverse learning styles and offering students of varying cultural backgrounds a beneficial learning experience, provide educators with one solution to help assist with their increased workload (Jefferies, 2001).

Computer simulation usage increased dramatically in medical education during the last decade (Hammond, Bermann, Chen, & Kushins, 2002). In healthcare education, computers are used for training, evaluation, and assisting in certification (Satava, 2001). During completion of the medical-based computer simulation, students are presented with signs and symptoms specific to each case. They evaluate the information, request additional information, re-evaluate, and continue with this cycle until a diagnosis is made (Downs, Friedman, Marasigan, & Gartner, 1997). The computer compares possible actions based on the expected value of the potential outcomes of those actions. It takes into account the possible actions students can take and the relationship between these actions and their potential outcomes (Downs et al., 1997).

Patient simulations are computer activities that mimic the reality of the clinical environment. They are designed to demonstrate procedures and facilitate critical thinking.
and decision making skills (Jeffries, 2001). According to Abbey (2002), Lowdermilk and Fishel (1991), and Weller (2004), interactive simulation can bridge the gap between the preclinical didactic and clinical application. It allows the students to practice, make mistakes, learn from the feedback given, and improve problem solving and decision making skills. The interactive simulated patient experience should be included early in the curriculum to introduce the principles of clinical problem solving to students (Lowdermilk & Fishel, 1991). At the completion of the case simulation, students interact with their simulated patients. This student-patient interaction teaches students to see the problem from patients’ as well as from their own points of view (Abbey, 2002). Weller (2004) stated that there is a lack of opportunities for undergraduate students to develop skills appropriate to working with other team clinicians. Based on Weller’s research, students are generally very enthusiastic about simulation-based learning.

Students participating in Weller’s (2004) study agreed that knowing what to do in certain situations and actually being able to do it are two different skills. They stated that participating in problem-based simulation helped them to bridge the gap. Students evaluated this problem-based simulation highly because they had the opportunity to manage realistic medical emergencies on their own without any serious consequences such as causing their patients harm (Weller, 2004).

Based on Lewis’s (2003) findings, the overall efficacy of computer assisted learning (CAL) is directly related to the students’ involvement. CAL could be used to provide students with exposure to different presentation styles, repeated real-life scenarios, and problem solving exercises (Hamilton, Furnace, Duguid, Helms, &
Simpson, 1999; Lewis, 2003). Students using CAL reported the lecture materials to be more interesting and reinforcing than material from the textbooks. Students were highly enthusiastic about the multimedia interactive method of teaching (Davis, Wythe, Rozum, & Gore, 1997).

Healthcare education is highly dependent on the patient presented during the students’ clinical rotations, but students’ exposure to patients has become limited (Jefferies, 2001; Pickell, Medal, Mann, & Staelder, 1986). Thus, some students might not be exposed to unique conditions (Satava, 2001). Client access to specialized healthcare providers has assisted in reducing students’ overall exposure (Pickell et al., 1986). Therefore, it is difficult for students to develop clinical reasoning, communication, and evaluation skills (Pickell et al., 1986). Simulations provide a risk-free learning environment, interactive learning, unlimited practice exercises, and immediate feedback. Simulations provide students with virtual patients suffering from conditions with predictable signs, symptoms, and behaviors, and these patients are available at the students’ convenience (Issenberg et al., 1999). Many simulations used in healthcare education measure students’ cognitive knowledge, but do not assess their motor skills and critical thinking abilities (Pattalochi, 2002). Therefore, in order to assist in development of these skills educators must choose computer simulation software wisely.

Shim, Brock, and Jenkins (2005) explored the opinion of experts regarding essential components in online simulations. Sixty-four percent reported using computer-case simulations (CCS) for teaching and 59% reported that they developed cases for CCS. All participants showed an interest in using CCS as a part of their lectures.
However, only 9% were interested in developing CCS due to time constraints (Shim et al., 2005). The survey respondents identified the following to be essential for successful simulation: 1) an opportunity to generate a differential diagnosis, 2) feedback on users’ decisions, 3) an opportunity to request and receive test results, and 4) an opportunity to practice taking patient histories. Based on this survey, the most important features of online CCS were routine tasks and teaching the problem solving skills (Shim et al., 2005). Computer case simulations have to meet specific criteria to serve as a valuable teaching method in the classroom and as a self-directed study. Table 3 summarizes these elements along with their effect on students.
Table 3

**Elements of Effective Computer Simulation**

<table>
<thead>
<tr>
<th>Elements of Computer Simulation</th>
<th>Effect on the Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part of total educational curriculum</td>
<td>Allow students to build upon their prior knowledge</td>
</tr>
<tr>
<td>Performance summary at the end</td>
<td>Give students feedback on their overall performance</td>
</tr>
<tr>
<td>Performance summary of each section</td>
<td>Give students feedback on their performance in specific domains</td>
</tr>
<tr>
<td>Present variety of conditions</td>
<td>Allow students to evaluate uncommon conditions or conditions that are difficult to evaluate during clinical experience. Bridge the gap between preclinical didactic and clinical experience</td>
</tr>
<tr>
<td>Provide a map of progress</td>
<td>Provide information for further evaluation and can be used for discussions with others</td>
</tr>
<tr>
<td>Built toward students’ needs</td>
<td>Allow students apply specific knowledge and skills learned in class at their level</td>
</tr>
<tr>
<td>Unlimited practice</td>
<td>Allow students practice as many times and as often as desired</td>
</tr>
<tr>
<td>Allow making mistakes</td>
<td>Allow students learn from their mistakes</td>
</tr>
<tr>
<td>Provide immediate feedback</td>
<td>Promote individual learning. Guide students while giving them hints. Correct students approach and suggest better solutions. Allow students to deal with consequences of their actions</td>
</tr>
<tr>
<td>Allow unconstrained manner actions</td>
<td>Allow students to perform action like in a real life</td>
</tr>
<tr>
<td>Unlimited time</td>
<td>Allow students to complete it, review it, and learn from it</td>
</tr>
<tr>
<td>Scoring logical progression</td>
<td>Provide students with tangible results evaluating their progression through the problem</td>
</tr>
</tbody>
</table>

**Computer Simulations and Other Instructional Methods**

Qayumi et al. (2004) conducted a study comparing the effects of three instructional methods on medical students’ performance: computer assisted (CP), text-
based, and a combination of these two methods (CP-and-text). The performance scores of
students participating in the CP and CP-and-text groups improved significantly more than
the scores of students participating in the text-based group (Qayumi et al., 2004). The
participants were divided into three levels: low-, medium-, and high-achievement
students. Based on this division of students and their scores, low-achievement students
performed significantly worse in the text-based instruction group than did medium- and
high-achievement students. However, low-achievement students’ performances in the CP
and CP-and-text groups were not significantly different from the performances of the
medium- and high-achievement students (Qayumi et al., 2004). The students scoring in
the medium-level achievement group benefited significantly more from the CP-based
instructional method than did other students. Students in the high-level achievement
group did not seem to benefit more from any particular instructional method. Based on
these findings, computer assisted instruction had the most significant impact on students
with low overall achievement and the least impact on students with high overall
achievement. Thus, computer assisted instruction enriches the study environment and
helps students who are not successful in traditional learning environments (Qayumi et al.,
2004). Based on their study results, Qayumi et al. (2004) also concluded that students
participating in the CP or CP-and-text instructional method found their study
environment to be significantly more meaningful than did students participating in text-
based instruction. Students participating in the text-based group reported difficulties
concentrating, as well as their learning environment to be less comfortable. They also
were less likely to participate in future studies of the same type (Qayumi et al., 2004).
Maleck et al. (2001) conducted a study comparing four different teaching methods. Group A used computer-based cases with interactive elements, Group B used computer-based cases without interactive sections, Group C used paper-based cases with interactive elements, and Group D served as a control group. Students could choose between voluntarily attending lectures (45min/wk) or using textbooks on their own. Participants in Group C rated their concentration the highest, followed by Groups A and B (Maleck et al., 2001). There was a significant difference in the perception of time limit between groups. Participants in Group B reported having enough time for the tasks. However, participants in Groups A and C reported a lack of time as being a major problem. Participants in Groups A and C rated interactivity highly (89%), and 42% of students in Group B missed the interactivity. Group C rated the element of interactivity as highly enjoyable. Students rated the use of textbook and lecture attendance very low (1.7 and 1.9, respectively, on scale of 1 - 6). There was a significant increase in knowledge in Groups A, B and C, with group B participants improving the most. The interactivity was valued highly by the participants. The results from the post-test showed a significant improvement for all experimental groups. There was no significant improvement in the performance of control Group D (Maleck et al., 2001).

Most studies reported that computer-simulated instruction is as good as, and sometimes even is better than, traditional lectures (Calhoun, Allen, Meek-Chilton, & Clark, 1986; Cohen & Dacanay, 1992; Dori & Yochim, 1994; Kulik & Kulik, 1991; Littlefield et al., 2003; Rouse, 2000; Satava, 2001; Shim et al., 2005). Computer assisted learning (CAL) helps students with varying learning styles to learn more effectively
However, Norman (1982) pointed out that CAL should not be used as a substitute to conventional teaching methods, but as an aid to improve effectiveness.

**Computer Instruction Use in Athletic Training Education Programs**

Electronic learning, or e-learning, can be used in two different ways in education: synchronously and asynchronously (Wright, Stewart, Wright, & Barker, 2002). With synchronous delivery, the students and their instructor are communicating in real time. This is achieved by traditional classroom delivery, satellite lecture, videoconference sessions, cable, and/or live television. Conversely, during asynchronous delivery, students access the lecture material at any time of the day and from any location (Wright et al., 2002).

The asynchronous delivery is missing real-time communication between students and instructors (Wright et al., 2002). However, asynchronous delivery provides a more student-centered and project-based learning environment compared to traditional written and practical evaluation tests (Wright et al., 2002). Athletic training education can benefit from being able to deliver multimedia material asynchronously over the Internet. It is challenging for clinical instructors who are supervising athletic training students during their clinical rotations to create realistic injury or illness scenarios for practice purposes. The real-life experience truly is limited without real-life injuries. It is impossible for the athletic training students to observe every possible and unique injury they might face in their future careers during their clinical rotations. Thus, computer simulation programs might serve as a learning and assessment tool to recognize areas for improvement in
students’ knowledge or in the program curriculum (Bennett, 2002). Simulated case scenarios delivered via internet can assist in recreating realistic injury scenarios, and therefore can help to improve students’ decision making skills (Wright et al., 2002).

Computer-based instruction (CBI) is any form of instruction using the computer to present information. The two main forms of CBI are computer assisted instruction (CAI) and interactive video (Fincher & Wright, 1996). CAI can be used as a stand-alone teaching method or as a supplement (Keane, Norman, & Vickers, 1991). To date, there is limited published research that addresses the effectiveness of computer software use in athletic training education.

The academic demands on faculty as well as on students are increasing. Computer technologies would be beneficial as an extension to existing pedagogic methods (Starkey, 2002). Due to the dynamic nature of athletic training education, there is a need for increased development of athletic training education software and completion of further research to reveal factors which influence the effectiveness of computer-based instruction in athletic training education (Fincher, Abdulla, Sridharan, Houghton, & Henke, 1998).

Wiksten, Patterson, Antonio, De La Cruz, and Buxton (1998) compared students’ performances on written and practical examinations based on the teaching method of traditional lecture versus the teaching method of traditional lecture plus the use of a compact disk read only memory (CD-ROM) during an upper-extremity injury evaluation course. Students taught by the traditional lecture method with the additional use of a CD-ROM performed significantly better than the control group on both types of
examinations, and reported that they would use the CD-ROM on regular basis if available (Wiksten et al., 1998).

Athletic training education programs use computer assisted instruction more frequently than interactive video (Fincher & Wright, 1996). The computer-based instruction method is mainly used for tutorials, drills, practices, and simulations. The tutorial provides students with new information, asks them questions, and provides immediate feedback (Fincher et al., 1998). Students learn through repetition and from immediate feedback. Simulated real-life scenarios provide students with the opportunity to develop decision making skills and critical thinking in a safe environment (Fincher et al., 1998). Interactive computer simulations provide athletic training students at all levels with the possibility to improve their critical thinking and decision making skills (Castle, 2000). A computer simulation program also could be used for continuing education, as computer simulations can be used to update certified athletic trainers and athletic training students on the proper procedures for emergency treatment of catastrophic injuries that certified athletic trainers and athletic training students do not often encounter (Castle, 2000; Heinrichs, 2002; Mensch & Ennis, 2002; Turocy, 2002).

Computer simulations can decrease the inconsistency of athletic training students’ clinical experiences while at the same time allowing them the opportunity to practice skills other than those that they apply during their clinical rotations (Iserson, 1999). In a well-developed computerized simulation, the degree of realism creates a more accurate testing tool than paper-and-pencil simulation tests (Bersky & Yocom, 1994). However, computerized simulation does lack the ability to provide real-life experiences of the type
that students receive during their clinical education through observation and hands-on learning (Bersky & Yocom, 1994).

Castle (2000) developed Computerized-Traditional Athletic Training Simulation Instrument (C-TATSI) and investigated the correlation between athletic training students’ performance on it and the written-simulation portion of the Board of Certification exam (WS-BOC). Both instruments included eight simulation problems, and each of the eight problems contained between 50 and 100 possible actions. Students’ performance on C-TATSI was not found to be a significant predictor of students’ performance on the WS-BOC examination. However, students’ performance on C-TATSI was similar to their performance on WS-BOC (Castle, 2000). Although the C-TATSI does not predict students’ performance on WS-BOC, it is valuable preparation tool for students getting ready for the BOC exam (Castle, 2000).

**Benefits of Computer Simulations**

The use of computer simulations in the education process enables instructors to identify students’ learning and skills deficiencies (Kowlowitz, Hoole, & Sloane, 1991). It can be used as a learning tool as well as an assessment tool. Computer simulations are helpful in assuring that students have been exposed to uncommon conditions (Hammond et al., 2002; Lowdermilk & Fishel, 1991; Satava, 2001). Also computer simulations automatically provide performance data for assessment (Kneebone, 2003).

Computer assisted instruction (CAI) enhances computer literacy, improves decision making skills, and helps to increase students’ performance (Lowdermilk & Fishel, 1991). When employed, students respond positively and report having increased
motivation towards learning (Jeffries, 2001). It is important that teachers create positive conditions for learning to take place, and these positive conditions must be complemented by motivated students who take advantage of the provided educational environment (Kneebone, 2003).

The interactive CD-ROM in education provides students with additional learning time and repetitions (Jeffries, 2002). With use of the interactive CD-ROM, computer assisted learning (CAL) is available to students every day and at any time. Students can use it at their convenience, at their own pace, and with unlimited possibilities of repetitions (Rosenberg, Grad, & Matear, 2003). Immediate feedback and interactive learning are important benefits of computer simulations. Students are actively participating while completing assignments in CAL (Norman, 1982).

Immediate feedback from computer aided instructions (CAIs) along with interaction helps students who prefer active participation and concrete experience as their instructional method (Lowdermilk & Fishel, 1991). It generally is assumed that students learn the best through active participation (Tomey, 2003). While using computer simulations, students receive individual instruction, which usually is impossible to provide in regular classroom settings (Norman, 1982). This learning method encourages students to make a connection between their prior knowledge and the final solutions that they come up with (Jeffries, 2001). Students are allowed to repeat and review the material as many times as they desire (Norman, 1982).

The advantage of problem solving via computer simulation is that students must work through a patient problem which enhances their problem solving skills within the
context of clinical practice (Abbey, 2002). Educational outcomes from using simulation teaching methods are knowledge, skill performance, learner satisfaction, critical thinking, and increased self-confidence (Jeffries, 2001). Educational studies investigating the retention of material in traditional lecture settings versus through simulation methods have found simulation methods to be as good as if not better than traditional lecture settings in some instances (Jeffries, 2001).

Mallott et al. (2005) reported that students enjoy working with the computer-case simulation because it allows them to exercise their knowledge and skills through a trial-and-error approach. Students want to make mistakes and see what consequences they would have to face. Providing this opportunity for learning by error makes computer simulations an excellent self-learning tool (Barach et al., 2001; Mallott et al., 2005). Students are motivated to learn more if they have a positive experience with simulation training. They need to see that the material and their performance with it produces immediate and tangible results (Barach et al., 2001). Simulation teaching methods are student-oriented as opposed to the traditional classroom setting which is teacher-centered (Jeffries, 2001). Using computer simulation as a teaching method sets up the expectation for students to be self-directed learners. Students have to be motivated during simulations, and thus it is important for them to know the rules for the activity (Jeffries, 2001).

Another important factor in medical education is students’ confidence. Marshall et al. (2000) evaluated resident students’ perceptions of simulated clinical calls as a medical educational tool, and analyzed how this experience affected the students’ self-
ratings of their confidence. The students were provided with 15 simulated clinical scenarios over a three-year period. The results of this study showed that students’ confidence levels increased significantly after completing this course. The students evaluated the simulated clinical calls course as a beneficial educational modality with an average evaluation score of 4.35 out of 5 (Marshall et al., 2000). Jeffries study (2001) also concluded that the simulation activities tended to increase students’ self-confidence in their critical thinking and in their clinical proficiencies.

Students need to be motivated to succeed. For example, students completing multiple self-evaluation quizzes as a part of computer aided instruction had significantly greater change in scores as compared to students who completed only single quizzes per each chapter (Kneebone, 2003). According to Lowdermilk and Fishel (1991), this is referred to as a possible “computer addiction,” meaning that the students involved in the study often were not able to let go until they had perfected their performance. And by working to perfect their performance, some students demonstrated an increase in knowledge of the material. Self-evaluation is necessary for self-directed learning to take place (Lowdermilk & Fishel, 1991).

Lynch, Steele, Palensky, Lacy, and Duffy (2001) investigated whether learning preference and attitude towards computers influence the acquisition of knowledge using computer assisted instruction material. Based on their findings, computer assisted instruction provides an effective type of instructional method producing a significant increase in knowledge over a four- to six-week period (Lynch et al, 2001).
Students’ View of the Use of Computer Simulation

Kulik and Kulik (1991) conducted a meta-analysis examining students’ attitudes towards their subject matter. Thirty-four studies were included, and twenty of them reported computer-based instruction group students having had more positive attitudes towards their subject matter than those students involved only in traditional classroom learning (Kulik & Kulik, 1991). Jeffries (2001) had similar findings, and concluded that many studies investigating learners’ satisfaction with simulation teaching and learning methods showed that students were satisfied with the computer-based instruction learning method. Students found their experiences with simulation to be valuable, and the majority of students felt that the simulations were realistic.

Richardson (1997) performed a similar study, in which students’ perceptions and learning outcomes of computer assisted instruction and traditional classroom lecture were compared. One group was taught using the traditional lecture methods, a second group received instruction via computer assisted lectures, and a third group participated in computer laboratory assignments. Based on the results, computer methods ranked significantly lower than traditional classroom lectures in students’ opinions about the effectiveness of the three methods of teaching used in this study (Richardson, 1997). Students completing computer assignments felt that this method was not time efficient. However, students scored significantly higher on objective tests after completing the material session over computer laboratory assignments. Students participating in computer assisted lectures also scored higher than students taught via traditional lecture sessions (Richardson, 1997).
Computer Simulation Designs

Computer-based simulations are becoming more popular on the educational market. Many instructional simulations interact with the user. However, simulations used during examinations are structured more towards assessment of skills and include fewer instructions for the student (Pattalochi, 2002).

Kulik and Kulik (1991) completed a meta-analysis on computer-based instruction (CBI) as a teaching and learning method in medical education. In 81% of the studies, students participating in computer-based instruction classes performed better on examinations than did students participating in traditional classroom lecture groups. Ninety-four percent of the studies reported students significantly favoring computer-based instructions over traditional classroom lectures (Kulik & Kulik, 1991). CBI was most effective when the treatment time was limited to four weeks or less increasing the performance 0.42 SD. However, when CBI was used for a longer period of time, such as for an entire academic year, this positive effect was less visible. Kulik and Kulik (1991) believe that this was due to the different ways of measuring students’ achievements that were employed in long- and short-term studies. Another explanation offered by Kulik and Kulik (1991) was the “Hawthorne Effect”—that is, a novelty effect takes place when students are stimulated by increased motivation due to a new form of treatment. However, this novelty loses its effect when the treatment is used for a longer period of time (Kulik & Kulik, 1991). This meta-analysis suggests that computer-based instructions, or any other computer-simulation software, serves as a beneficial supplement to traditional didactic methods.
Mallott et al. (2005) recommended the following requirements for a computer simulation to be a successful and valuable tool in medical education: the simulation needs to allow students to make errors, and needs to accommodate trial-and-error pathways. Students participating in this study were not concerned as much about the trial-and-error pathways. However, more advanced students were more mastery-process oriented. They wanted to find the diagnosis with fewer trial-and-error attempts. Computer-case simulations need to allow students to perform actions in an unconstrained manner, as by doing so they will more accurately mimic real life. All students’ actions need to be followed by an appropriate response, and students need to learn to deal with the consequences of their actions (Mallott et al., 2005).

Ruderich et al. (2004) discussed the importance of software being both flexible and realistic for efficient learning to occur. The software must provide cases within a variety of medical professions that allow learners to complete examinations and, when mistakes are made, force them to deal with the consequences (Ruderich et al., 2004). Access to this information along with an unlimited amount of time to complete the problem allows less-experienced students to complete the case study, review the problem, and learn from it (Mallott et al., 2005).

Kneebone (2005) provided a framework for using computer simulations in education as well as criteria for evaluating their effectiveness. For any simulation to be an effective learning tool, it needs to focus on a well-defined subject area and provide opportunities for gradual improvement and immediate feedback (Kneebone, 2005). Learning takes place following practice. Therefore, the ability repeatedly practice these
skills results in successful instruction. Students need to be interested and motivated to learn new material presented during a simulation, and they need to progress from external to self-directed learning (Kneebone, 2005). For clinical simulations, the program needs to simulate clinical situations as realistically as possible. This includes initially providing students with little information, thereby forcing them to investigate the situation. As they investigate, new information is provided until the simulation is completed. Simulations should be designed to evolve from simple to complex (Jeffries, 2001).

**Evaluation of Students’ Performance Using Computer Simulation Programs**

Simulations can be used as an evaluation tool where students are graded on their performance by being awarded points while completing the simulation. This provides objective evidence of students’ performance (Kneebone, 2003). According to Hammond et al. (2002), it is important not to score the performance using an absolute score but to focus on evaluating the logical progression used by the student. More proficient students will perform fewer intermediate tasks on their way to the solution, and thus will score less on the absolute scoring system than students performing many additional tasks (Hammond et al., 2002). Downs et al. (1997) developed a decision analytic approach for scoring performance on computerized case simulations. Students completing clinical simulations must receive more than a single score based on whether the diagnosis was correct or not. The grading approach needs to take context into account. It is obvious that some misdiagnoses are worse than others and this should be reflected in the scoring evaluation (Downs et al., 1997). Miller (1990) suggested a framework for assessment as a pyramid. The top two categories on the pyramid evaluate students on actions and
performance. The third category is competence, while knowledge belongs on the bottom of the pyramid, illustrating it as the most important part of education upon which everything else is built.

Two national medical examinations, previously administered in paper format have been transformed into computer-based examination. The United States Medical Board Licensing Examination (USMLE) was previously administered as a paper-and-pencil test until the late 1990s, at which time it was switched to a Computer-Based Testing (CBT) format (Dillon, Clyman, Clauser, & Margolis, 2000). The National Board of Medical Examination (NBME) has been the primary provider of testing tools in the medical academic field (Dillon et al., 2000). It was established in 1915, and until the 1950s the NBME consisted of essay questions and a bed-side oral examination. In the 1950s, the essay part of the examination was discontinued and replaced by a Multiple-Choice Question (MCQ) test format. The bed-side oral examination continued to be a part of the NBME until the mid-1960s, when it was replaced by a Patient Management Problem (PMP), a paper-format test presenting patient case scenarios (Dillon et al., 2000). This PMP presented examinees with patient scenarios in which they selected from a list of possible actions. Students received feedback on their chosen action by uncovering information that reflected their action. This portion of the NBME was used until mid-1980s, when it was dropped from the examination due to concerns regarding reliability and interpretations (Dillon et al., 2000). In November 1999, computer-case simulations began to be included in the NBME (Dillon et al., 2000). Presently, the NBME consists of three parts, two of which use MCQ and a third component which is based on computer-
case simulations (CCS) (Dillon et al., 2000). Dillon and his colleagues researched the relationship between MCQ and CCS on the NBME. They concluded that there was a moderate relationship between examinees’ performance on MCQ and CCS. Thus, CCS could be used in the overall assessment of physicians’ competence (Dillon et al., 2000).

Summary and Conclusion

The main goal of healthcare education is to prepare skilled healthcare practitioners who are critical thinkers. Critical thinking is a vital component of athletic training. Certified athletic trainers must be able to recognize, analyze, and interpret various components of each patient’s unique health issues (Starkey, 1997). In order for certified athletic trainers to accomplish this, their athletic training education should combine traditional classroom learning and clinical experiences so students are allowed to develop the skills necessary to think critically. Throughout the athletic training student’s academic career, the development of the skills necessary to critical thinking needs to take place. These skills include: problem identification, problem definition, exploration, applicability, and integration. As athletic training students progress through their education, their ability to synthesize basic individual skills into larger-scale skill sets needs to be assessed. By utilizing a computer technology instructional delivery method in the classroom, athletic training students’ critical thinking skills may be enhanced.

The computer technology instructional delivery methods in athletic training education are evolving. However, the majority of athletic training education evaluation tools implement multiple-choice exams that promote surface learning. Problem-based learning presented via computer simulation appears to be an efficient and effective
learning approach that should be incorporated in athletic training education to promote necessary critical thinking (Heinrichs, 2002).

The use of computer simulations in the education of healthcare professionals has increased dramatically in recent years. This increase is supported by the ability of computer simulations to promote critical thinking, bridge gaps between classroom didactic and clinical education, and decrease required lecture time. It also offers self-directed learning and self evaluation opportunities to students, provides students with unlimited access in the students’ preferred environment, and offers realistic problems. Students are more motivated to solve computer simulation problems than they are to learn material directly from textbooks and journals.

Most tests in medical education rely on written examinations that cannot assess how an examinee would react in a real-life situation. Some may consider these types of tests to measure surface learning only, which is defined as the memorization of material without an understanding of the context (Marton & Säljö, 1976). In the surface learning approach, students are minimally engaged with the task at hand, and only concentrate on memorization in order to gain a passing grade. On the other hand, a deep learning approach, as described by Marton & Säljö (1976), involves an intention to understand the meaning of information. A deep learning approach is encouraged by instructors when exams that require a deep understanding of material are used to evaluate students. Problem-based learning and computer simulations may be thought of as a deep learning approach because they promote critical analysis skills, self-directed learning, and problem solving. Higher-order multiple-choice questions fail to measure effective clinical
performance, and so it is recommended to use computer simulation to evaluate athletic training students’ clinical performance.

The studies reviewed in this chapter showed that using computer simulation as a problem-based learning method is beneficial to students, since doing so promotes deep-level learning and critical thinking. However, educators need to choose appropriate evaluation tools in order to be able to evaluate students’ performance to the optimal level and as close to their career specifics as possible.
CHAPTER THREE: METHODOLOGY

Introduction

Chapter three presents a full description of the methods and instruments used in this study. It is divided into the following sections: research design, null hypotheses, operational definitions, participants, instrumentation, and data collection.

The purpose of this study was to investigate athletic training students’ levels of critical thinking and the effects of these levels on their performance on computer simulations related to the physical evaluation of athletic injuries. As a secondary purpose, this study investigated the effect of four weeks of self-directed learning using computer simulations on students’ performances on computer simulation scenarios related to the physical evaluation of athletic injuries. This study was specific to junior- and senior-level athletic training students enrolled in the entry-level Athletic Training Education Program at Pennsylvania State institution.

Participants’ protection was considered throughout this study. Permission from Ohio University Office of Research Compliance Institutional Review Board and a data collection site institution Institutional Review Board was granted prior to the initiation of this study (IRB 2007-011-27-A, 08E012, Appendices I, J).

Research Design

The method used in this study to analyze collected data was a non-experimental two groups mixed-design split-plot repeated measures. This design allowed the researcher to investigate both within and between the groups’ factors. That is, it allowed the researcher to analyze students’ performance on five computer simulations over a
period of four weeks (within group factors) and to investigate the difference between the higher and the lower critical thinking skills levels students’ groups (between group factors). Based on their performance on the California Critical Thinking Skills Test, students were divided into groups of higher and lower critical thinking skills levels. The intention was to divide the participants into two groups of equal amount of members with a cut off equal to median value. However, this was impossible due to a small cluster of participants scoring the same score close to the median.

Thirty-four junior- and senior- entry-level athletic training students from Pennsylvania State institution Athletic Training Education Program (ATEP) were asked to participate in this study for a total of four weeks. During this time, participants were given full rights to use the higherlevelthinking.com website, which provided them with unlimited access to computer simulations. Students were required to complete at least one specific simulation at the end of each week of the study, and students’ scores for that simulation were recorded.

An initial meeting was held with the participants in the study to inform them of both the purpose and the procedures of the study. Each participant was provided with an informed consent form (Appendix B). Participants then were given the option to sign this form. General demographic forms (Subject’s Questionnaire, Appendix C) also were distributed and completed by the participants, each of whom filled in their research ID number, age, and gender as a part of the general demographics questionnaire.

During the first session of data collection, all participants completed The California Critical Thinking Skills Test (CCTST) in a controlled environment in the
computer laboratory on campus. Students then were divided into two independent groups based on their performance on CCTST. Group A included participants with higher critical thinking skills levels and Group B included participants with lower critical thinking skills levels.

During the second session of data collection, students completed the Computerized-Traditional Athletic Training Simulation Instrument (C-TATSI) examination. After this data collection, students were given unlimited access to the higherlevelthinking.com website for a period of four weeks. Participants were instructed to complete at least one specific simulation at the end of each week.

These data were used in investigating an association between students’ critical thinking skills levels and their performance on computer simulations, as well as the effect of self-directed learning on students’ performance on computer simulations. All participants underwent the same four-week period of self-directed learning via computer simulations.

**Research Questions**

The following research questions (RQ) were used to frame this study:

**RQ1**: Do students who have lower levels of critical thinking skills perform the same on computer-simulations as students who have higher levels of critical thinking skills during a period of four weeks of self-directed learning?

**RQ2**: Do students with higher levels of critical thinking skills perform better on computer-simulations than students with a lower critical thinking skills level?
RQ3: When presented with computer-simulations as a self-directed learning tool for four weeks, do the students’ performances on completing computer-simulations improve?

**Null Hypothesis**

$HO_1$: There will be no significant difference in performance on computer simulations between the lower critical thinking skill level students group (lct) and the higher critical thinking skill level students group (hct). There will be no difference between the two groups’ of athletic training students and within their performance on the five computer simulations.

$HO_2$: There will be no significant difference in the mean scores of students’ performances on the computer simulations between the lower critical thinking skill level students group (lct) and the higher critical thinking skill level students group (hct).

$$HO_2: \mu_{lct} = \mu_{hct}$$

$HO_3$: There will be no significant difference in the students’ performances on five computer simulations over the period of four weeks.

$$HO_3: \mu_{S1} = \mu_{S2} = \mu_{S3} = \mu_{S4} = \mu_{S5}$$

**Operational Definition of Variables**

1. **Subjects’ performance on the CCTST**

A continuous independent variable reporting subjects’ performance on the CCTST. This variable is a percentile score of a relative ranking of each participant compared to the population taking this examination. This percentile is
based on the sum of participants’ scores in the analysis, inference, and evaluation sections of this test.

2. *Subjects’ performance on computer simulations*

   A continuous dependent variable reporting subjects’ performance on computer simulations. The participants completed five computer simulations that were scored based on absolutely indicated (+2 pt.), indicated (+1 pt.), neutral (0 pt.), contraindicated (-1 pt.) and absolutely contraindicated (-2 pt.) values. This score was recorded as a percentage of maximum possible points.

3. *C-TATSI score*

   A continuous dependent variable reporting subjects’ performance on eight specific computer simulations at the beginning and at the end of the study. This score represents each participant’s total score on eight of the simulations presented on this test. The maximum score students were able to reach was 10,115 points. The scoring rubric for these simulations is presented in Table 2.

4. *Higher-level critical thinking skills group*

   Participants placed at 61.4 percentile and higher of four-year college students on CCTST.

5. *Lower-level critical thinking skills group*

   Participants place lower than 61.4 percentile of four-year college students on CCTST.
Participants

Participants for this study were entry-level junior- and senior-level athletic training students attending Pennsylvania State institution. Thirty-three students (fifteen seniors and eighteen juniors; twelve men and twenty-two women; all between the ages of nineteen and twenty-two) were asked to participate in this study. This number of participants was sufficient to obtain power $p = 0.8$ for five repeated measures with a size effect $\gamma = 0.4$.

Participation in this study was voluntary. The participants were provided with an information letter (Appendix A). All subjects were required to read the Human Subjects Informed Consent Form (Appendix B), and were given an option to sign this form before participating in the study. The California Critical Thinking Skills Test was administered to all participants at the beginning of the study in order to investigate their critical thinking skill levels. All data were kept confidential, and were used only for this study.

The athletic training education program (ATEP) where this study took place has been an accredited athletic training education program since 1974. The ATEP is an accelerated entry-level athletic training program. Athletic training students admitted to the program can graduate in three and one-half years, or seven semesters. Students are admitted into this ATEP after both successful completion of the application process and an interview during the second semester of each student’s freshman year. During the first semester of their sophomore year, students are concurrently enrolled in the Care and Prevention of Athletic Injuries course and the Integrative Approach in Athletic Training I course. In the Care and Prevention of Athletic Injuries course, students are introduced to
basic healthcare and prevention of athletic injuries practices. In the Integrative Approach in Athletic Training I course, students apply their knowledge from the Care and Prevention of Athletic Injuries course in a hands-on setting.

In the following semester, ATEP students enroll in the Physical Evaluation of Athletic Injuries course and the Integrative Approach in Athletic Training II course. During the Physical Evaluation of Athletic Injuries course, students learn evaluation methods, tests, and protocols in order to be able to efficiently and correctly diagnose athletic injuries and illnesses. The material covered in this course is important because higher-level courses build on the knowledge acquired during this course. If students misdiagnose an injury, their use of therapeutic modalities and their development of rehabilitation and reconditioning plans will be affected.

The Physical Evaluation of Athletic Injuries course is taught over one semester, and meets for a 75-minute period twice a week. The Integrative Approach in Athletic Training II course is taught simultaneously with the Physical Evaluation of Athletic Injuries course, and also meets for a 75-minute period twice a week. The testing procedures used in the Physical Evaluation of Athletic Injuries course consist mainly of multiple-choice, fill-in-the-blank, and matching questions. Electronic scantron sheets often are used. The Integrative Approach in Athletic Training II course serves as a hands-on course, and is related to the materials taught in the Physical Evaluation of Athletic Injuries course. All of the testing procedures in this course utilize check-off sheets that evaluate students’ performance on specific psychomotor skills. Currently, there is no computer simulation involvement in either of these two courses. The professor who
teaches these two courses has been a Certified Athletic Trainer for seventeen years, has worked at this institution for fifteen years, and has been teaching these two courses for the past eleven years.

**Instrumentation**

The following instruments were used during this study to evaluate students’ critical thinking skills levels, to assess students’ performance on computer simulations, and to provide treatment using problem-based case study simulations.

*The California Critical Thinking Skills Test Form 2000*

The California Critical Thinking Skills Test (CCTST) was purchased from The California Academic Press, Millbrae, CA. The California Academic Press analyzed the data relating to the CCTST for this study, and provided the researcher with the results for each participant’s critical thinking skills level, along with overall group results.

The CCTST was administered to the participants in this study via the Internet. The CCTST is a standardized, 34-item, multiple-choice test which targets the core critical thinking skills of analysis, interpretation, inference, evaluation, and explanation (Facione, Facione, Blohm, & Gioncarol, 2002). The CCTST Form 2000 provides item contexts with a broad representation of critical thinking skills. It is an improved, richer, and more robust tool for evaluating critical thinking skills than either Form A (Facione, 1990a) or Form B (1992), both of which were used for years. The CCTST is based on the APA Delphi Consensus Conceptualization of Critical Thinking (Facione et al., 2002). Validation studies regarding the CCTST provided internal consistency estimates ranging from .68 to .70 (Facione et al., 2002). Facione (1990a) found a CCTST correlation $r =$
.20, \( p < .000 \) with GPA, \( r = .44, \ p < .000 \) with Scholastic Aptitude Test (SAT) math score, and \( r = .55, \ p < .000 \) with SAT verbal score (Appendix D).

**Problem-based Medicine Case Studies**

The simulations used in this study were purchased from Ericka Zimmerman at the University of Charleston (www.higherlevelthinking.com). Permission for their use was obtained from the same source. These simulations were used during a four-week period. Each student was required to complete a minimum of one specific computer simulation per week. Students had free unlimited access to these simulations to practice their skills, and seven new practice example simulations were presented each week. Each entry was evaluated, and all entries were documented for further evaluation, as were data such as how many practice examples each student completed, and his or her performance scores (Appendix E). These simulations were scored based on indications and contraindications of the responses chosen by the participants. The following values were awarded to each response: absolutely indicated actions (2 pt.), indicated actions (1 pt.), neutral actions (0 pt.), contraindicated actions (-1 pt.) and absolutely contraindicated actions (-2 pt.).

This computer website was chosen as a self-directed learning instrument due to its availability over the Internet, which allowed students to use it at anytime and in any environment they were comfortable studying. This software is user-friendly, and no prior computer experience is necessary in order to use it. Also, it provides the instructor with statistic data on each participant’s performance, including participants’ performance on each simulation and on each question. These data are beneficial both in assessing
students’ overall performance and in providing information as to which areas may or may not need improvement.

*The Computerized Traditional Athletic Training Simulation Instrument*

The Computerized-Traditional Athletic Training Simulation Instrument (C-TATSI) was used to evaluate each participant’s performance before and after the use of computer simulations as a self-directed learning method (Appendix F). The C-TATSI was developed by Dr. Ray Castle (The University of Southern Mississippi) and his colleagues in 2000. It is software that contains eight athletic training simulations, each with 50 possible responses and no more than 100 possible answers.

The scoring procedures on the C-TATSI are similar to the procedures used by the Board of Certification, Inc. and Columbia Assessment Services, Inc. in order to calculate scores for the written-simulation examination part of the BOC exam (Castle, 2000). However, due to proprietary issues, the information for calculating scores could not be released by the BOC, Inc. or by Columbia Assessment Services, Inc. Each of the sections of the eight simulations presented in the C-TATSI was weighted based on its critical value to successful performance as an athletic trainer. A value of 1 represents the most critical value and a value of 7 represents the least critical value. Each response to the simulations was based on absolutely indicated, indicated, neutral, contraindicated and absolutely contraindicated values. Absolutely indicated (AI) responses represented actions vital to limit severe harm to the patients. Indicated (I) responses represented actions that needed to be performed to limit any harm to the patients. Actions performed or not performed that resulted in no harm to the patients were ranked as neutral (N).
Responses that would result in harm to the patients were ranked as contraindicated (C), and those actions that would cause severe harm to the patients were rated as absolutely contraindicated (AC). The score for each simulation was a combination of that simulation’s weighted scores and each response’s value score. The absolutely indicated (AI) responses received full points, and indicated (I) responses received half of the points awarded for an absolutely indicated response. The neutral responses (N) received no points, the contraindicated (C) responses received the negative equivalent of the points awarded for an indicated response, and the absolutely contraindicated responses (AC) received the negative equivalent of the points awarded for an absolutely indicated response. The tabular form of the scoring rubric is presented in Table 4. This instrument met content validity criteria of 80%, and reliability $R = 0.61$.

Table 4

<table>
<thead>
<tr>
<th>Section relative rating value</th>
<th>AI</th>
<th>I</th>
<th>N</th>
<th>C</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70</td>
<td>35</td>
<td>0</td>
<td>-35</td>
<td>-70</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>30</td>
<td>0</td>
<td>-30</td>
<td>-60</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>25</td>
<td>0</td>
<td>-25</td>
<td>-50</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>20</td>
<td>0</td>
<td>-20</td>
<td>-40</td>
</tr>
<tr>
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<td>30</td>
<td>15</td>
<td>0</td>
<td>-15</td>
<td>-30</td>
</tr>
<tr>
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<td>20</td>
<td>10</td>
<td>0</td>
<td>-10</td>
<td>-20</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>-5</td>
<td>-10</td>
</tr>
</tbody>
</table>

Data Analysis

All data collected were analyzed via SPSS15. Descriptive statistics are reported in tabular form and are used for comparison through analyses as follows in Table 5.
Table 5

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>C-TATSI performance score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Computer simulation 1 score (Athl. Tr. Clin. Exp. I)</td>
</tr>
<tr>
<td></td>
<td>Computer simulation 2 score (Head and Cervical Spine)</td>
</tr>
<tr>
<td></td>
<td>Computer simulation 3 score (NATABOC Mock Exam)</td>
</tr>
<tr>
<td></td>
<td>Computer simulation 4 score (Written Sim Mock Exam)</td>
</tr>
<tr>
<td></td>
<td>Computer simulation 5 score (Athl. Tr. Clin. Exp. III)</td>
</tr>
<tr>
<td></td>
<td>C-TATSI performance score</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>California Critical Thinking Skills Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group A – higher critical thinking skills level</td>
</tr>
<tr>
<td></td>
<td>Group B – lower critical thinking skills level</td>
</tr>
</tbody>
</table>

Summary

This chapter describes the methods and procedures for the design used in this study. This study evaluated the four-week use of computer simulations as a self-directed learning tool as well as athletic training students’ performance on computer simulations related to the physical evaluation of athletic injuries. This study also investigated athletic training students’ critical thinking skills levels, and their possible relationship to students’ computer simulation performances. Understanding these relationships would help ATEP educators improve ATEP education, thus helping educators to prepare students for their careers as effectively as possible. This study used the California Critical Thinking Skills Test (CCTST) to evaluate students’ critical thinking abilities. The CCTST was chosen for
use in this study due to the fact that research exists suggesting the CCTST is more specific to allied health professions than other critical thinking evaluation tests.

Computer-Traditional Athletic Training Simulation Instrument (C-TATSI) and the website www.higherlevelthinking.com were used as self-directed learning and assessment tools.

This study used a non-experimental two group a mixed split-plot design repeated measures to investigate the relationship between students’ critical thinking skills levels and their performance on computer simulations, and 2) the effect of four weeks of using computer simulations as a self-directed learning tool on students’ performance on scenarios related to physical evaluation of athletic injuries. The research design, including research questions and null hypothesis, were presented in this chapter. The definitions of variables and instrumentation were presented, and data collection and data analysis methods were outlined. In chapters four and five, the results and discussion are provided.
CHAPTER FOUR: RESULTS

Introduction

This study investigated athletic training students’ levels of critical thinking and the effects of these levels on their performance on computer simulations related to the physical evaluation of athletic injuries. As a secondary purpose, this study investigated the effect of four weeks of self-directed learning using computer simulations on students’ performances on computer simulation scenarios related to the physical evaluation of athletic injuries.

This chapter presents the results from the research instruments. It is organized into five sections addressing demographics (i.e., gender, age, class rank, QPA, ATGPA); the California Critical Thinking Skills Test performance (i.e., participants’ performance on the CCTST); practice computer simulations (i.e., the total number of completed computer simulations as a self-directed learning method over the period of four weeks); hypothesis testing; and additional data analysis.

Population

All of the participants came from Pennsylvania State institution and met the inclusion criteria: junior- or senior-level athletic training students enrolled in a CAATE-accredited entry-level athletic training education program (ATEP). Thirty-three students were recruited to participate in this study, and 32 (97% of those recruited) completed this study. All participants completed the CCTST, the pre- and post-test CTATSI, five specific computer case studies, and also participated in self-directed learning over the Internet site www.higherlevelthinking.com.
Demographics

The thirty-two \((n = 32)\) athletic training students (ATS) attending an entry-level Athletic Training Education Program (ATEP) at one of the Pennsylvania State institutions participated in this study. The participants provided demographic data related to age, gender, class rank, cumulative grade point average (QPA), and grade point average for athletic training classes (ATGPA). The participants consisted of 22 (68.8%) females and 10 (31.3%) males; 18 juniors (56.3%) and 14 seniors (43.8%). Participants ranged from 19 to 22 years of age with the mean of 20.94. The mean for juniors was 20.44 and for seniors 21.57 years of age. The participants’ mean QPA was 3.53 and ATGPA 3.48 on the four-point scale. The juniors group had a mean QPA of 3.58 and ATGPA of 3.53. The seniors had average QPA 3.46 and ATGPA of 3.41 on the four-point scale.

California Critical Thinking Skills Test Performance Demographics

Thirty-two participants took the California Critical Thinking Skills Test (CCTST) during the first meeting session in the control environment of library on the university Campus. Their performance was evaluated by California Academic Press via the Internet. Results were provided to each participant and the researcher following completion of the test. Participants were divided into two groups based on their performance on the CCTST. The intent was to divide the participants into two groups with a cut off equal to median value. However, this was impossible due to a small cluster of participants scoring the same score close to the median. Thus, the group with higher level of critical thinking included 18 students: 12 females and 6 males; of which were 10 juniors and 8 seniors with a mean age of 21 years; a mean cumulative QPA of 3.647; and a mean
ATGPA of 3.631. The lower-level critical thinking group had 14 students: 10 females and 4 males; 8 juniors and 6 seniors; and the mean age for this group was 20.86 years. Their mean cumulative QPA was 3.377 and mean ATGPA was 3.277 (See Table 6).

Table 6

<p>| California Critical Thinking Skills Test (CCTST) Groups’ Demographics |
|-----------------------------|----------------|----------------|----------------|----------------|-----------------|----------------|</p>
<table>
<thead>
<tr>
<th>CCTST Group</th>
<th>Age</th>
<th>Female</th>
<th>Male</th>
<th>Seniors</th>
<th>Juniors</th>
<th>QPA</th>
<th>ATGPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLCT</td>
<td>21.00</td>
<td>12</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>3.65</td>
<td>3.63</td>
</tr>
<tr>
<td>LLCT</td>
<td>20.86</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>3.38</td>
<td>3.28</td>
</tr>
</tbody>
</table>

An independent t-test was conducted to evaluate the difference between the QPA and ATGPA of the higher-level and lower-level critical thinking skills groups. The test was significant for QPA t (-2.63), p = .015. This suggests students in the higher-level critical thinking groups had significantly higher QPA than students in the lower-level critical thinking group. The test was also significant for ATGPA t (-3.142), p = .005 suggesting that students in the higher-level critical thinking groups had significantly higher ATGPA than students in the lower-level critical thinking group (See table 7).
Table 7

Participants’ Cumulative Grade Point Average and Grade Point Average in Athletic Training Classes

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HLCT</td>
<td>18</td>
<td>3.65</td>
<td>.23</td>
</tr>
<tr>
<td>LLCT</td>
<td>14</td>
<td>3.38</td>
<td>.33</td>
</tr>
<tr>
<td>ATGPA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HLCT</td>
<td>18</td>
<td>3.63</td>
<td>.23</td>
</tr>
<tr>
<td>LLCT</td>
<td>14</td>
<td>3.28</td>
<td>.37</td>
</tr>
</tbody>
</table>

The California Critical Thinking Skills Test provides test-takers with two scores following the exam. The first score is the based on their responses to the questions, whereas the second score is their relative percentile ranking to other four-year college students. The mean score for four-year college students is 16.8 with a maximum score possible of 34 points. The average first score for this population was ($M = 17.53, SD = 3.64$). Table 8 summarizes the scores by grade level and critical thinking group. The average score for the group of students with higher-level critical thinking skills was ($M = 20.11, SD = 2.37$). The average score for the group of students with lower-level critical thinking skills was ($M = 14.21, SD = 1.76$). The average score for juniors was ($M = 17.67, SD = 3.73$) and the average score for seniors was ($M = 17.36, SD = 3.65$).
Table 8

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juniors</td>
<td>18</td>
<td>17.67</td>
<td>3.73</td>
</tr>
<tr>
<td>Seniors</td>
<td>14</td>
<td>17.36</td>
<td>3.65</td>
</tr>
<tr>
<td>HLCT</td>
<td>18</td>
<td>20.11</td>
<td>2.37</td>
</tr>
<tr>
<td>LLCT</td>
<td>14</td>
<td>14.21</td>
<td>1.76</td>
</tr>
</tbody>
</table>

The second score reported is the overall relative ranking score to other four-year college students. This score compares the participants’ performances from this study to other four-year college and university students. The participants of this study were placed at 55\(^{th}\) percentile of four-year college students (\(M = 55.26, SD = 23.35\)). A complete breakdown is presented in Table 9.
Table 9

*Mean and Standard Deviation of Percentile Rank of California Critical Thinking Skills*

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juniors</td>
<td>18</td>
<td>55.81</td>
<td>23.21</td>
</tr>
<tr>
<td>Seniors</td>
<td>14</td>
<td>54.70</td>
<td>23.48</td>
</tr>
<tr>
<td>HLCT</td>
<td>18</td>
<td>72.65</td>
<td>11.24</td>
</tr>
<tr>
<td>LLCT</td>
<td>14</td>
<td>33.06</td>
<td>11.94</td>
</tr>
</tbody>
</table>

Computer Simulations

All participants completed several computer simulations as a part of their self-directed learning during this study. Students had unlimited access to these computer simulations and were allowed to take them at their convenience. They completed a required minimum of one per week. The average of completed computer simulations per week for all participants was \((M = 2.87, SD = 2.93)\). The overall descriptive statistics for gender, class rank, and assigned critical thinking group are presented in Table 10.
Table 10

*Completed Practice Computer Simulations*

<table>
<thead>
<tr>
<th>Groups</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Total</td>
<td>3.03</td>
<td>2.83</td>
<td>5.03</td>
<td>4.84</td>
</tr>
<tr>
<td>Juniors</td>
<td>3.17</td>
<td>2.94</td>
<td>5.11</td>
<td>4.24</td>
</tr>
<tr>
<td>Seniors</td>
<td>2.86</td>
<td>2.77</td>
<td>4.93</td>
<td>5.69</td>
</tr>
<tr>
<td>LLCT</td>
<td>2.57</td>
<td>2.44</td>
<td>4.64</td>
<td>4.50</td>
</tr>
<tr>
<td>HLCT</td>
<td>3.39</td>
<td>3.11</td>
<td>5.33</td>
<td>5.20</td>
</tr>
<tr>
<td>Females</td>
<td>2.68</td>
<td>2.64</td>
<td>4.05</td>
<td>3.85</td>
</tr>
<tr>
<td>Males</td>
<td>3.80</td>
<td>3.19</td>
<td>7.20</td>
<td>6.22</td>
</tr>
</tbody>
</table>

**Hypothesis Testing**

The purpose of this study was to investigate if athletic training students' performance on computer simulations on evaluation of athletic injuries reflect their critical thinking level. The secondary purpose of this study was to investigate whether using self-directed learning utilizing computer simulations over a four week period effects student performance on computer simulations related to the physical evaluation of athletic injuries. In the following section, each hypothesis is identified and analyzed for statistical significance.
Different Levels of Critical Thinking and Performance on Computer Simulation: \( H_{01} \)

The first hypothesis asks if students’ level of critical thinking is reflected in their performance on computer simulations related to evaluation of athletic injuries. How does four weeks of self-directed learning using computer simulations effect student’s with higher-level critical thinking and lower-level critical thinking and do these groups differ? A repeated measures analysis of variance (ANOVA) was conducted to examine the differences between the two groups.

Internal consistency of the five computer simulations was measured utilizing Cronbach’s coefficient alpha. Reliability analysis yielded alpha coefficient of .730 for the Athletic Training Clinical Experience I simulation, .731 for the Head, Neck and Cervical Spine simulation, .947 for the BOC Mock Exam simulation, .914 for the Written Simulation Mock Exam simulation, and .817 for the Athletic Training Clinical Experience III simulation. A repeated-measures analysis of variance (ANOVA) with the Greenhouse-Geisser correction showed that there was no significant effect of students’ level of critical thinking on their performance on the five computer simulations, \( F(2.03, 60.92) = .447, p = .645 \). There was no significant difference in groups’ (higher and lower level critical thinking) performance on the five computer simulations. Therefore, the null hypothesis is not rejected. Table 11 and Figure 1 represent participants’ performances on the five computer simulations based on their levels of critical thinking.
<table>
<thead>
<tr>
<th>Groups</th>
<th>Simulation 1</th>
<th>Simulation 2</th>
<th>Simulation 3</th>
<th>Simulation 4</th>
<th>Simulation 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Higher CT</td>
<td>59.06</td>
<td>14.88</td>
<td>61.67</td>
<td>19.80</td>
<td>79.44</td>
</tr>
<tr>
<td>Lower CT</td>
<td>54.43</td>
<td>16.26</td>
<td>62.36</td>
<td>15.78</td>
<td>74.79</td>
</tr>
<tr>
<td>Total</td>
<td>57.03</td>
<td>15.58</td>
<td>61.97</td>
<td>17.88</td>
<td>77.41</td>
</tr>
</tbody>
</table>
Figure 1. Comparison of the means on the five computer simulations between higher-level and lower-level critical thinking groups.

Comparison of the Critical Thinking Groups Mean Performance on the Computer Simulations: $H_{02}$

This hypothesis investigates whether there was a significant difference in mean performance scores between the higher-level critical thinking and lower-level critical thinking groups. For data analysis a repeated-measures analysis of variance (ANOVA) test of between-group effect was conducted. The test was not significant, $F(1,30) = 1.84,$
\[ p = .186. \] Therefore, the null hypothesis \( H_{02} \) was not rejected. Table 12 represents each groups performance mean.

Table 12  
*Group Statistics for Performance Mean on Computer Simulations between Higher-Level Critical Thinking and Lower-Level Critical Thinking Groups*

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower-Level CT</td>
<td>14</td>
<td>61.3</td>
<td>6.06</td>
</tr>
<tr>
<td>Higher-Level CT</td>
<td>18</td>
<td>64.4</td>
<td>6.69</td>
</tr>
</tbody>
</table>

**Comparison of Participants’ Performances on the Five Computer Simulations: \( H_{03} \)**

The purpose of this hypothesis was to investigate if students’ performances on five computer simulations related to the physical evaluation of athletic injuries differed throughout the study over the four week period. The null hypothesis stated there would be no significant difference between the means of scores of students’ performances on the five computer simulations over the period of four weeks. A repeated measures analysis of variance was conducted to examine collected data. Although there was no significant difference between the groups’ (higher- and lower-level critical thinking) performance on five computer simulations, pairwise comparisons investigated possible differences between the five cases. The mean percentage scores for each case were as follows: *Athletic Training Clinical Experience I* 56.74\%, *Head and Neck Injuries* 62.01\%, *BOC Mock Exams’* 77.12\%, *Written Simulation Mock Exams’* 55.29\%, and
Athletic Training Clinical Experience III 63.09%. Data are presented in Table 13. Using pairwise comparisons with a confidence interval of 99%, it was found that participants’ performed significantly better on case # 3 BOC Mock Exam $M = 77.12\%$ utilizing $p < .01$ than on all the other cases. Therefore, the decision was to reject the null hypothesis $H_{03}$. Table 14 shows pairwise comparisons for all case simulations.

Table 13

*Estimated Marginal Means for Five Computer Simulations*

<table>
<thead>
<tr>
<th>Cases</th>
<th>M</th>
<th>St. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athl. Cl. Ex. I</td>
<td>56.74</td>
<td>2.79</td>
<td>51.04</td>
<td>62.44</td>
</tr>
<tr>
<td>Head &amp; Neck</td>
<td>62.01</td>
<td>3.24</td>
<td>55.40</td>
<td>68.62</td>
</tr>
<tr>
<td>BOC Mock Exam</td>
<td>77.12</td>
<td>1.64</td>
<td>73.77</td>
<td>80.46</td>
</tr>
<tr>
<td>Written Sim Mock</td>
<td>55.29</td>
<td>1.55</td>
<td>52.14</td>
<td>58.45</td>
</tr>
<tr>
<td>Athl. Cl. Ex. III</td>
<td>63.09</td>
<td>1.25</td>
<td>60.55</td>
<td>65.64</td>
</tr>
</tbody>
</table>
Table 14

Pairwise Comparisons of Five Computer Simulations

<table>
<thead>
<tr>
<th>Case (I)</th>
<th>Case (J)</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>-5.27</td>
<td>4.62</td>
<td>.266</td>
</tr>
<tr>
<td>3</td>
<td>20.37</td>
<td>2.86</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.45</td>
<td>2.14</td>
<td>.503</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-6.35</td>
<td>2.77</td>
<td>.029</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>-15.10</td>
<td>3.61</td>
<td>.000</td>
</tr>
<tr>
<td>4</td>
<td>6.72</td>
<td>3.85</td>
<td>.091</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-1.08</td>
<td>3.79</td>
<td>.778</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>21.83</td>
<td>1.49</td>
<td>.000</td>
</tr>
<tr>
<td>5</td>
<td>14.02</td>
<td>1.71</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>-7.80</td>
<td>1.50</td>
<td>.000</td>
</tr>
</tbody>
</table>

Note. Pairwise comparison was analyzed at $p < .01$.

Additional Data Analysis

Each participant completed the Computerized-Traditional Athletic Training Simulation Instrument (C-TATSI) prior to and after completing four weeks of self-directed learning. Participants completed various amounts of practice computer simulations as a self-directed learning method. These data were recorded and based on the amount of total completed simulations over the four week period. Participants were divided into two equal groups: a low number of completed practice simulations and a high number of completed practice simulations. Pre- and post-test C-TATSI performance
data were collected and analyze using a one-way ANOVA repeated measures within and between subjects factors. Using the Wilks’ Lambda criterion, the participants’ pre-test and post-test performance was not affected by the amount of completed practice simulations, Wilks’ Lambda = .971, $F = (1,30) = .905$, $p = .349$, multivariate $\eta^2_p = .029$. Therefore, no significant difference existed in the pre-test and post-test performance of the low practice group and the high practice group. Table 15 and Figure 2 outline the results of this analysis.

Table 15

*Pre-Test and Post-Test Performance on C-TATSI for Low Practice and High Practice*

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Practice</td>
<td>16</td>
<td>71.88</td>
<td>15.19</td>
</tr>
<tr>
<td>High Practice</td>
<td>16</td>
<td>70.81</td>
<td>14.02</td>
</tr>
<tr>
<td>Post-Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Practice</td>
<td>16</td>
<td>71.25</td>
<td>16.91</td>
</tr>
<tr>
<td>High Practice</td>
<td>16</td>
<td>74.00</td>
<td>9.68</td>
</tr>
</tbody>
</table>
Figure 2. Comparison of the means on pre-test and post-test C-TATSI between higher practice and lower practice groups.
The higher-level and lower-level critical thinking participants’ pre-test and post-test C-TATSI scores were analyzed using a one-way ANOVA repeated measures within and between subjects factors. Using the Wilks’ Lambda criterion, the participants’ pre-test and post-test performance was not affected by their level of critical thinking, Wilks’ Lambda = .975, $F = (1,30) = .775$, $p = .386$, multivariate $\eta^2_p = .025$. No significant difference was found between the higher-level and lower-level critical thinking groups’ pre-test and post-test performance. Table 16 and Figure 3 present the data.

Table 16

Pre-Test and Post-Test Performance on C-TATSI for Higher-Level and Lower-Level Critical Thinking Groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLCT</td>
<td>14</td>
<td>64.00</td>
<td>.15</td>
</tr>
<tr>
<td>HLCT</td>
<td>18</td>
<td>77.06</td>
<td>.11</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>71.34</td>
<td>.14</td>
</tr>
<tr>
<td>Post-Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLCT</td>
<td>14</td>
<td>67.29</td>
<td>.16</td>
</tr>
<tr>
<td>HLCT</td>
<td>18</td>
<td>76.78</td>
<td>.11</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>72.63</td>
<td>.14</td>
</tr>
</tbody>
</table>
Figure 3. Comparison of the means on the pre-test and post-test C-TATSI between the higher and lower level critical thinking groups.
Pre-test and post-test C-TATSI scores were also compared based on participants’ cumulative grade point average (QPA) and their grade point average in the athletic training classes (ATGPA). A repeated-measures analysis of variance (ANOVA) was used to analyze these data. Using the Wilks’ Lambda criterion, the participants’ pre-test and post-test performance was not affected by their QPA, Wilks’ Lambda = 1.0, $F(1,30) = .002$, $p = .964$. Neither was it affected by their ATGPA, Wilks’ Lambda = .997, $F(1,30) = .104$, $p = .749$, multivariate $\eta^2_p=.003$. Therefore, the participants’ QPA and ATGPA does not play an effect in the difference between participants’ pre- and post-test C-TATSI. Data divided by subjects’ ATGPA and QPA are presented in Table 17.
Table 17

*Pre-Test and Post-Test Performance on C-TATSI Based on Participants’ ATGPA and QPA*

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATGPA&lt;3.5/4.0</td>
<td>16</td>
<td>67.56</td>
<td>14.94</td>
</tr>
<tr>
<td>ATGPA&gt;3.5/4.0</td>
<td>16</td>
<td>75.12</td>
<td>12.35</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>71.34</td>
<td>14.02</td>
</tr>
<tr>
<td><strong>Post-Test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATGPA&lt;3.5/4.0</td>
<td>16</td>
<td>69.50</td>
<td>16.60</td>
</tr>
<tr>
<td>ATGPA&gt;3.5/4.0</td>
<td>16</td>
<td>75.75</td>
<td>9.34</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>72.63</td>
<td>13.63</td>
</tr>
<tr>
<td><strong>Pre-Test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QPA &lt;3.6/4</td>
<td>16</td>
<td>67.81</td>
<td>14.92</td>
</tr>
<tr>
<td>QPA&gt;3.6/4.0</td>
<td>16</td>
<td>74.88</td>
<td>12.52</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>71.34</td>
<td>14.02</td>
</tr>
<tr>
<td><strong>Post-Test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QPA &lt;3.6/4</td>
<td>16</td>
<td>69.00</td>
<td>16.59</td>
</tr>
<tr>
<td>QPA&gt;3.6/4.0</td>
<td>16</td>
<td>76.25</td>
<td>8.99</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>72.63</td>
<td>13.26</td>
</tr>
</tbody>
</table>
The California Critical Thinking Skills Test evaluates participants’ performance in five different areas specific to critical thinking. A repeated measures analysis of variance (ANOVA) was conducted to examine collected data. Using the Greenhouse-Geisser correction, the participants’ performance on induction, deduction, analysis, inference and evaluation was not affected by their level of education, $F(2.63, 78.86) = 0.05, p = .996$. No significant difference was found between the juniors and seniors’ participation on CCTST induction, deduction, analysis, inference, and evaluation. The overall breakdown for these specific areas based on participants’ class rank is presented in Table 18 and Figure 4.

Table 18

*Comparing Specific Portions of the California Critical Thinking Skills Test by Grade*

<table>
<thead>
<tr>
<th>Level</th>
<th>Induction</th>
<th>Deduction</th>
<th>Analysis</th>
<th>Inference</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Groups</td>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Juniors</td>
<td>60.79</td>
<td>9.25</td>
<td>44.45</td>
<td>17.85</td>
<td>68.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>68.25</td>
<td>19.33</td>
<td>53.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>39.39</td>
</tr>
<tr>
<td>Seniors</td>
<td>58.40</td>
<td>13.55</td>
<td>42.44</td>
<td>18.19</td>
<td>68.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>52.23</td>
<td>13.56</td>
<td>38.31</td>
</tr>
</tbody>
</table>
Figure 4. Comparison of participants’ scores on the CCTST sections based on their class rank.

The overall means for the five specific domains of CCTST were: induction $M = 59.74\%$, deduction $M = 43.57\%$, analysis $M = 68.30\%$, inference $M = 52.81\%$, and evaluation $M = 38.92\%$. The breakdown statistics for induction, deduction, analysis, inference and evaluation are provided in Table 19.
Table 19

Higher-Level and Lower-Level Critical Thinking Groups’ Computer Simulation Means

<table>
<thead>
<tr>
<th>CCTST</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction</td>
<td>32</td>
<td>59.74</td>
<td>11.20</td>
<td>1.98</td>
</tr>
<tr>
<td>Deduction</td>
<td>32</td>
<td>43.57</td>
<td>17.73</td>
<td>3.14</td>
</tr>
<tr>
<td>Analysis</td>
<td>32</td>
<td>68.30</td>
<td>18.41</td>
<td>3.25</td>
</tr>
<tr>
<td>Inference</td>
<td>32</td>
<td>52.81</td>
<td>13.46</td>
<td>2.38</td>
</tr>
<tr>
<td>Evaluation</td>
<td>32</td>
<td>38.92</td>
<td>14.47</td>
<td>2.56</td>
</tr>
</tbody>
</table>

A repeated measures analysis of variance (ANOVA) examined whether class rank had an effect on the results of the five computer simulations. The Greenhouse-Geisser correction showed the participants’ performance on the five computer simulations was not affected by their class rank, $F(2.13, 63.84) = 1.74, p = .182$. It was determined that no significant difference existed between the juniors’ and seniors’ performance on the five computer simulations. The overall breakdown for these simulations based on class rank is presented in Table 20 and Figure 5.
Table 20

Participants’ Performance on Computer Simulations Based on Class Rank

<table>
<thead>
<tr>
<th>Groups</th>
<th>Simulation 1</th>
<th>Simulation 2</th>
<th>Simulation 3</th>
<th>Simulation 4</th>
<th>Simulation 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Juniors</td>
<td>60.00</td>
<td>10.81</td>
<td>58.56</td>
<td>19.72</td>
<td>78.28</td>
</tr>
<tr>
<td>Seniors</td>
<td>53.21</td>
<td>19.96</td>
<td>66.36</td>
<td>14.71</td>
<td>76.29</td>
</tr>
</tbody>
</table>

Figure 5. Comparison of the participants’ scores on the five computer simulations based on their class rank.
The participants were divided into two groups based on their cumulative grade point average (QPA). Students’ with a QPA higher than 3.6/4.0 were placed into the higher QPA group, and students with a QPA lower than 3.6/4.0 were placed into the lower QPA group. Using the Greenhouse-Geisser correction, the participants’ performance on induction, deduction, analysis, inference and evaluation was affected by their QPA, $F(2.50, 74.97) = 5.86, p = .002$. Significant difference was found between the two group mean scores. The overall breakdown for these simulations based on participants’ class rank is presented in Table 21 and Figure 6.

Table 21

<table>
<thead>
<tr>
<th>Groups</th>
<th>Induction</th>
<th>Deduction</th>
<th>Analysis</th>
<th>Inference</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Higher QPA</td>
<td>58.82</td>
<td>2.71</td>
<td>51.84</td>
<td>14.12</td>
<td>66.96</td>
</tr>
<tr>
<td>Lower GPA</td>
<td>60.66</td>
<td>9.78</td>
<td>35.30</td>
<td>17.45</td>
<td>69.64</td>
</tr>
</tbody>
</table>
Figure 6. Comparison of the participants’ scores on the CCTST sections based on their QPA.

The participants were placed into two groups based on their grade point average in athletic training classes (ATGPA). The high ATGPA group consisted of students’ with a 3.5/4.0 or higher and those with a ATGPA lower than 3.6 were placed into the lower ATGPA group. A repeated measures analysis of variance (ANOVA) was conducted to examine data collected on the California Critical Thinking Skills Test (CCTST) regarding participants’ grade point average in athletic training classes. Using the Greenhouse-Geisser correction, it was determined that the participants’ grade point average in athletic training classes played a role in their performance on CCTST, $F(2.58, 77.49) = 4.68, p = .007$. It was determined that there was a significant difference between participants’
performances on CCTST based on their grade point average in athletic training classes.

The overall breakdown for these simulations based on participants’ class rank is presented in Table 22 and Figure 7.

Table 22

Higher and Lower ATGPA Groups’ Means Scores on Each Section of the California Critical Thinking Skills Test

<table>
<thead>
<tr>
<th>Groups</th>
<th>Induction</th>
<th>Deduction</th>
<th>Analysis</th>
<th>Inference</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>High ATGPA</td>
<td>59.93</td>
<td>11.81</td>
<td>52.94</td>
<td>12.89</td>
<td>69.64</td>
</tr>
<tr>
<td>Low ATGPA</td>
<td>59.56</td>
<td>10.93</td>
<td>34.19</td>
<td>17.21</td>
<td>66.96</td>
</tr>
</tbody>
</table>
Participants’ performances on the five computer simulations were investigated based on their cumulative grade point average (QPA). A repeated measures analysis of variance (ANOVA) was conducted to examine collected data on five computer simulations based on participants’ QPA. Using the Greenhouse-Geisser correction, it was determined that participants’ QPA was not a factor in their performance on the five computer simulations, $F(2.04, 61.05) = 0.16, p = .860$. It was determined that there was no significant difference between participants’ performances on the five computer simulations based on their QPA. The overall breakdown for these simulations based on participants’ class rank is presented in Table 23.

Figure 7. Comparison of the participants’ scores on the CCTST sections based on their ATGPA.
Table 2

Means Scores on Computer Simulations Based on QPA

<table>
<thead>
<tr>
<th>Groups</th>
<th>Simulation 1</th>
<th>Simulation 2</th>
<th>Simulation 3</th>
<th>Simulation 4</th>
<th>Simulation 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>High QPA</td>
<td>56.56</td>
<td>14.00</td>
<td>62.00</td>
<td>19.90</td>
<td>78.37</td>
</tr>
<tr>
<td>Low QPA</td>
<td>57.50</td>
<td>17.48</td>
<td>61.94</td>
<td>16.26</td>
<td>76.44</td>
</tr>
</tbody>
</table>

Participants’ performances on the five computer simulations also were investigated based on their grade point average in athletic training classes (ATGPA). A repeated measures ANOVA was conducted to compare the participants’ performances on five computer simulations based on participants’ ATGPA. Using the Greenhouse-Geisser correction, it was determined that participants’ ATGPA was not a factor in their performance on the five computer simulations, $F(2.06, 61.65) = .460$, $p = .638$. It was determined that there was no significant difference between participants’ performances on the five computer simulations based on their ATGPA. The overall breakdown for these simulations based on participants’ ATGPA is presented in Table 24 and Figure 8.
### Table 24

*Mean Scores on Computer Simulations Based on ATGPA*

<table>
<thead>
<tr>
<th>Groups</th>
<th>Simulation 1</th>
<th>Simulation 2</th>
<th>Simulation 3</th>
<th>Simulation 4</th>
<th>Simulation 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>High ATGPA</td>
<td>57.06</td>
<td>14.27</td>
<td>59.31</td>
<td>20.06</td>
<td>77.50</td>
</tr>
<tr>
<td>Low ATGPA</td>
<td>57.00</td>
<td>17.27</td>
<td>64.62</td>
<td>15.58</td>
<td>77.31</td>
</tr>
</tbody>
</table>

Figure 8. Comparison of the participants’ scores on the five computer simulations based on their ATGPA.
Summary

This chapter presented basic demographics, the results from the data analyses used to evaluate the three research questions and hypotheses, and additional analyses. The following summarizes the results of the three research questions and hypotheses:

1. Students’ levels of critical thinking did not affect their performances on the five computer simulations and no interaction was found between the higher level critical thinking group and lower level critical thinking group over the four week period.

2. The critical thinking level of participants did not affect their overall mean performance on five computer simulations.

3. The mean scores for each computer simulation were not significantly different from each other, except for the simulation BOC Mock Exam on which participants scored significantly better than on the other four computer simulations.
CHAPTER FIVE: SUMMARY, DISCUSSION, and CONCLUSION

This chapter contains a brief summary, discussion of the results, and conclusion of the study along with recommendations for future research.

Summary

This study investigated athletic training students’ levels of critical thinking in relation to performance on computer simulations. In addition, this study investigated the use of computer simulations as a tool for self-directed learning over a four-week period and its effects on students’ performances. The results of this study are specific to the CAATE-accredited entry-level athletic training education program (ATEP) at a Pennsylvania State institution.

Three null hypotheses guided the investigation of the effects of critical thinking levels and self-directed learning on computer simulation performance. Additional analyses examined for possible relationships of participants’ level of critical thinking with class rank, cumulative grade point average (QPA), and grade point average in athletic training courses (ATGPA).

The first hypothesis investigated whether the participant’s critical thinking level affects their performance on computer simulations related to the physical evaluation of athletic injuries. The main goal was to investigate if the difference between the groups’ performances stays consistent over the five computer simulations. The second hypothesis compared the critical thinking groups’ overall performance mean on the five computer simulations. The third hypothesis aided an investigation of the participants’ performances on each of the five computer simulations.
The goal of this research was to contribute to the athletic training literature related to teaching methods, computer simulations, and critical thinking. The sample consisted of thirty-two athletic training students attending a CAATE accredited entry-level Athletic Training Education Program at one of the Pennsylvania State institutions. All of the athletic training students (18 juniors and 14 seniors) had completed the Physical Evaluation of Athletic Injuries class prior to participating in the study.

Participants completed the California Critical Thinking Skills Test (CCTST) and a demographic information sheet at the beginning of the study. The CCTST contained 34 multiple-choice questions. The scores participants received included: overall score; percentile ranking to other four-year college students; and subsection scores for induction, deduction, analysis, inference, and evaluation. Two groups emerged. Students in the 64th percentile ($M = 72.65\%$) and above were placed into a Higher Level Critical Thinking group and students in less than the 64th percentile ($M = 33.06\%$) were positioned in the Lower Level Critical Thinking group.

All participants completed the Computerized Traditional Athletic Training Simulation Instrument (C-TATSI) prior to and at the conclusion of the four weeks. This instrument was developed by Dr. Ray Castle (Castle, 2000). It was not shown as a good predictor of students’ success on the Board of Certification (BOC) exam; however, students’ performances on C-TATSI were similar to their performance on the BOC exam (Castle, 2000). This instrument collected data to investigate the effect of participants’ four weeks of self-directed learning.
Participants received unlimited access to computer case simulations on through the www.higherlevelthinking.com website for the four week testing period. This software also evaluated student performance on five specific simulations. The first computer simulation was *Athletic Training Clinical Experience I*, which focused on evaluation skills related to various football injuries. The second case study completed at the end of the first week was *Head, Neck, and Cervical Spine Injuries*. During this computer simulation, students were tested on two scenarios related to head and cervical spine injuries. The third computer case study was the *NATABOC Mock Exam*, which included four case scenarios. This computer simulation prepared athletic training students for the BOC exam by giving them the opportunity to complete practice exams similar to the BOC exam and to identify their areas needing improvement. The fourth computer simulation completed at the end of the third week was the *Written Simulation Mock Exam*. This computer simulation included four specific injury scenarios, where students could practice a portion of the former BOC exam. The final computer simulation, *Athletic Training Experience III*, was completed at the end of the fourth week. This simulation included evaluation of the head, cervical spine, and upper extremities.

All three hypotheses were analyzed using a repeated measure analysis of variance (ANOVA) with the level of critical thinking groups (higher and lower level critical thinking groups) as the independent variable and the five computer simulations scores as the dependent variables. Additional data analyses focused on critical thinking levels and the supplementation of computer simulations to traditional lecture teaching methods. The data were analyzed to investigate the relationship between participants’ overall
cumulative grade point average (QPA) and grade point average in athletic training classes (ATGPA) according to their level of critical thinking. Analyses were also conducted to examine the effect on participants’ QPA and ATGPA on the five specific computer simulation scores.

The numbers of completed practice computer simulations per each week were analyzed and the participants were placed in two groups: high number of completed simulations and low number of completed simulations. Their pre-test and post-test C-TATSI performances were analyzed using a repeated measures ANOVA with groups serving as an independent variable and C-TATSI performance as a dependent variable. A final analysis compared junior and senior students’ scores on the CCTST as well as their performance compared to students from other four-year colleges.

**Summary of Quantitative Findings**

*Different Levels of Critical Thinking and Performance on Computer Simulations: H₀₁*

This hypothesis sought to determine if the level of critical thinking has an effect on students’ performance on computer simulations. The null hypothesis stated there would be no significant difference in participants’ performance on the specific five computer simulations between the two critical thinking level groups (higher and lower level critical thinking groups) and that there would be no interaction between these two groups’ performances.

*Results and Conclusions.* The decision was to fail to reject the null hypothesis. There was no significant difference in the performance on the computer simulations between the two critical thinking groups. It appears that both groups of
students performed similarly on the computer simulations. Although overall performance on computer simulations was not affected by participants’ critical thinking level, there was a significant correlation between the critical thinking and case simulation number five Athletic Training Clinical Experience III. This may be caused by the simulation questions in this scenario requiring more in depth thinking than the other computer case simulations.

Critical thinking includes problem solving and decision making (Heinrichs, 2002). The participants solved clinical problems via computer simulations. According to McDade (1995) and Rauen (2001), many higher education curriculums have implemented case studies into their programs to promote critical thinking. Heinrichs (2002) stated that solving a clinical problem helps students think critically. Students are actively involved during clinical problem solving and this active learning improves critical thinking (Browne & Freeman, 2000). Castle (2000) stated that computer simulations improve athletic training students’ critical thinking and decision making skills. The main goal of athletic training education is to help students become critical thinkers and healthcare professionals (Starkey et al., 2004). In healthcare education, computer simulations are used for training, evaluation and assisting in certifications (Satava, 2001). Although critical thinking is a necessity for healthcare professionals, based on this study athletic training students’ performances on the computer simulations do not reflect their level of critical thinking.

Although the groups’ performances on the computer simulations were not significantly different, students with higher levels of critical thinking outscored students
with lower levels of critical thinking on three out of the five computer simulations. The other two computer simulations were completed with a similar score for both groups. This may be due to higher QPA and ATGPA scores of the higher level critical thinking group.

Direct application of this finding may include that traditional written exams and computer simulations can be used in the assessment of athletic training students’ knowledge and decision making skills. Calhoun, Allen, Meek-Chilton, and Clark (1986), Cohen and Dacanay (1992), Dori & Yochim (1994), Kulik and Kulik (1991), Littlefield et al. (2003), Rouse (2000), Satava (2001), Shim et al. (2005), all reported that computer-simulated instructions are as good as, and sometimes even better than traditional lectures. However, based on the results of this study, computer simulations should not be used as an indicator of entry-level athletic training students’ ability to think critically.

Comparison of the Means of Participants’ Performances on Five Computer Simulations between the Critical Thinking Level Groups: H02

This hypothesis intended to determine if there was a significant difference in the overall performance on the specific five computer simulations between the two levels of critical thinking groups (higher and lower level critical thinking groups). The hypothesis stated that there would be no significant difference in the overall means between the two groups.

Results and Conclusions. The decision was to fail to reject the null hypothesis. The results of the ANOVA repeated measures indicated that there was no significant performance difference in the overall means of computer simulations performance.
between the two groups. As mentioned in the results and conclusions of hypothesis $H_{01}$ students with higher levels of critical thinking outscored the students with lower levels of critical thinking in three of five computer simulations. They also outscored them with a mild difference in the overall mean for all five computer simulations scoring $M = 64.45\%$ compared to $M = 61.3\%$ of the lower level critical thinking group. This is not a significant difference and might be due to chance. Another important factor that might play a role in these results is a low number of participants and unequal number of subjects in each group.

The direct application of this conclusion is similar to hypothesis $H_{01}$. It is impossible for the athletic training students to be able to observe every possible and unique injury during their clinical education. Thus, computer simulation programs might serve as a learning and assessment tool to recognize weaknesses in students’ knowledge (Bennett, 2002). Computer simulations may be used as a motivational (Heinrich, 2002; Jeffries, 2001; Kulik & Kulik, 1991; Mensch & Ennis, 2002) and self-directed learning instrument (Barrows, 1990; Lowdermilk & Fishel, 1991; Shim et al., 2005), but given the data collected in this study it should not be used for assessing athletic training students’ abilities to think critically.

**Comparison of Participants’ Performance on Five Computer Simulations: $H_{03}$**

This hypothesis attempted to determine if there was a significant difference between overall means for each of the five computer simulations. The null hypothesis stated that there would be no significant difference between the means of overall scores for each of the five computer simulations over the period of four weeks.
Results and Conclusions. The null hypothesis was rejected. It appears that participants scored significantly better on the computer simulation 3 BOC Mock Exam compared to the other four computer simulations. The mean for case 1 Athletic Training Clinical Experience I was 56.74%, case 2 Head and Neck Injuries had mean of 62.01%, case 3 BOC Mock Exam had significantly higher mean of 77.12% than all the other cases, case 4 Written Mock Exam $M = 55.29\%$, and case 5 Athletic Training Clinical Experience III averaged 63.09% (Table 4).

There are several possible reasons for this significant difference in students’ performance on simulation 3. The first possible reason is the difficulty level of each simulation. Although all simulations were assessed on a common scale (using 1 point for indicated responses, 2 points for strongly indicated responses, 0 points for neutral no harm no gain responses, -1 point for contraindicated and -2 for strongly contraindicated responses), the story tree in the third simulation might have been based on a different difficulty level.

The second possible reason for the significant difference might have been the participants’ motivation. Kneebone (2003) stated that students need to be motivated to succeed and they perform better if the material presented to them is related to their area of study (Tapper, 2004; Davies, 2002). Although all presented simulations were presented the same way it is possible that students were increasingly motivated to find out their performance on the BOC Mock Exam. Fourteen of the athletic training students were planning to challenge the BOC exam within the next four months following the study and all eighteen juniors will challenge this exam the following year. The
motivation to know their level of preparedness for the BOC might have had some bearing on their performance.

In addition, the number of practice computer simulations completed during the week prior to challenging the BOC Mock Exam simulation was significantly larger than the other three weeks. The mean average of completed simulations for week 2 was 5.03, week one $M = 3.03$, week 3 $M = 1.59$, and week’s 4 $M = 1.84$. This additional practice during the second week may have also improved the students’ scores.

The direct application may include the development of case simulations. Some computer simulations are very similar to situations students already had to deal with during their clinical rotations and some simulations might include uncommon challenging cases students might never see during their clinical experiences.

**Additional Findings**

All participants completed Computerized-Traditional Athletic Training Simulation (C-TATSI) prior to and after completing four weeks of self-directed computer simulations. The purpose of this type of data collection was to examine participants’ performances on identical computer simulations after the treatment. Due to a low number of participants a conclusion based on these data is not statistically relevant. According to Castle (2000), students’ performance on C-TATSI was similar to their performances on the NATABOC exam (former BOC exam). According to Qayumi et al. (2004), computer simulations helped students who are not successful in the traditional learning environment. The data collected in this study does not support these claims. No significant differences in pre- and post-test scores on C-TATSI were found between
students with higher or lower QPA and ATGPA, assuming that students with lower QPA and ATGPA are less successful in traditional learning environment. Possibly the results of this study were affected by the low number of participants and the timing of the data collection. It is possible that students with lower ATGPA and QPA need longer than four weeks using computer simulations as a self-learning method.

However, Lynch et al. (2001) stated that computer assisted instruction produced a significant increase in knowledge over a four-to-six-week period. Based on Kulik and Kulik’s (1991) meta-analysis, computer instruction was most effective when the treatment time was limited to four weeks or less. They suggest that this is due to a “Hawthorne Effect” where a novelty effect takes place when students are stimulated by increased motivation due to a new method of teaching/learning. Thus, further study investigating the frequency of completed practice computer simulations each week over a longer time period and its effect on pre- and post-test scores may be beneficial to athletic training educators when planning to use computer simulations in their classes.

During this study, participants completed on average 2.87 computer simulations per week as a form of self-directed learning. There were on average of 3.03 computer simulations completed during the first week. Participants reached the peak during the second week when they averaged 5.03 computer simulations. Their performance decreased during weeks three (1.56 simulations) and four (1.84 simulations). It is worth mentioning that the seniors challenging the BOC exam in April increased their numbers of practice computer simulations during the fourth week of treatment, which was two weeks before the BOC exam. Thus, it seems that students participating in this study
completed the greatest number of practice computer simulations during week two when students knew they would be evaluated on a *NATABOC Mock Exam* simulation. As well, the seniors completed more computer simulations the closer they were to taking the BOC exam.

The researcher placed participants into two groups based on the amount of completed practice simulations. Their pre- and post-test scores on C-TATSI were analyzed, and revealed no significant difference between the groups who had completed higher or lower amounts of practice computer simulations. However, students who completed seven and more practice computer simulations experienced a mild gain of 3.19% in their performance scores for the C-TATSI. Comparisons of measures were made for pre-test to post-test scores for students who completed less than seven computer simulations; their performances worsened by .53%. These changes are minimal and might be related to chance and/or the time of data collection at the end of the semester.

The participants’ performance on pre- and post-test C-TATSI was examined in regards to their level of critical thinking. It was concluded that the level of critical thinking had no effect on participants’ performance on pre-test and post-test C-TATSI. Castle’s (2000) research did not test for the various levels of critical thinking; however, the C-TATSI results from his study were shown to be similar to the former BOC examination results. Future research may want to investigate if C-TATSI and/or the BOC examination reflect students’ critical thinking level as a longitudinal study utilizing a larger sample size.
All participants challenged the California Critical Thinking Skills Test (CCTST) in a controlled environment in a computer laboratory at the university library. As mentioned in previous sections, CCTST provides test takers with their score for each section (induction, deduction, analysis, inference, and evaluation) along with giving them the mean score of 4-year college students for each section. The second score that participants received was their overall percentile ranking with other 4-year college students. Students participating in this study averaged a 55.33 percentile rank, which means they were placed five percentile rankings above the 50th percentile rank of the national average. It was interesting to investigate the breakdown of the CCTST into its sections. There was no significant difference between the higher level of critical thinking and lower level critical thinking groups in regards of specific areas of CCTST. There was no significant difference in any of these sections for the participants’ performances when compared to the overall national average of 4-year college students. However, the athletic training students juniors and seniors scored $M = 59.74\%$ on induction while the national average is $56.06\%$; for deduction the participants score $43.7\%$ and national average is $42.76\%$; and for analysis participants’ $M = 68.30\%$ and national $M = 63.43\%$. Participants in this study had an average of $52.93\%$ on the inference measure, whereas the national average was $49.06\%$, and they scored on average $38.92\%$ in evaluation section while the national average was $41.09\%$. Due to a low number of participants in this study, it is impossible to make specific conclusions based on these data. There was no significant difference in the means of the participants and the national average; however, the participants in this study outscored the national average in all CCTST
sections, except evaluation. There is a minimal difference in the means; however, this might slightly indicate a possible future study using a larger sample of entry-level athletic training students.

Facione et al., (2002) stated that inductive reasoning happens when students decide the evidence provided means that a given conclusion is probably true. Deductive reasoning takes place when students decide it is impossible for the considered conclusion to be false, given that all premises of their arguments are true. Students use analytical skills while dividing arguments. Inference skills are used to draw conclusions based on the evidence, and use all the other skills mentioned above. During the evaluation thinking process, people decide how strong or weak a person’s arguments are regarding believability of a given statement. Although there are no significant differences, it is interesting to see that students participating in this study scored above the national average for four-year college students in evaluating evidence and arguments. However, their score was below the national average in determining the believability of the arguments. All areas of critical thinking are important for athletic training professionals. Future study might evaluate athletic training students’ performance on specific areas of CCTST with a larger sample size.

Based on the results of this study, students’ cumulative grade point average (QPA) and grade point average in athletic training (ATGPA) were reflected in their performance on the California Critical Thinking Skills Test. One of the goals of athletic training education is to help students become critical thinkers (Starkey et al., 2004). Educators assess students’ performances by giving grades that are all reflected in the
grade point average. Although the results of this study are not statistically relevant because of the low power due to a small sample size, it is nice to see that the grades students are given do reflect their critical thinking. Students with higher QPA and higher ATGPA performed significantly better on the CCTST than students in the lower QPA and ATGPA groups. On the other hand, participants’ QPA and ATGPA did not reflect their performances on the five computer simulations. This may suggest that all computer simulations were related to one athletic training class, Evaluation of Athletic Injuries, which is presented to the students during their first semester in the athletic training program. Because the participants in this study have been able to apply their injury evaluation techniques for a minimum of two academic semesters, the computer simulations used in this study may have not been challenging enough. These results may have been different had the computer simulations been of another subject in which the students did not have the appropriate time to practice their clinical skills. Another possible explanation may be that computer simulations assess athletic training students’ clinical knowledge without evaluating their critical thinking. This may be due to a low difficulty level of problem-scenarios that did not challenge students enough to implement critical thinking to solve the simulation.

**Summary and Conclusion of this Study**

The purpose of this study was to investigate if athletic training students’ performance on the evaluation of athletic injuries computer simulations reflect their critical thinking level. The secondary purpose of this study was to investigate whether using computer simulations as self-directed learning over a four week period effects
student performance on the physical evaluation of athletic injuries computer simulations. Critical thinking is beneficial to healthcare professionals and their patients (Rauen, 2001), thus it is a necessary skill for athletic training students to master. The use of computer simulations in medical education has dramatically increased during the last decade (Hammond et al., 2002). Many healthcare education programs use computer simulations as a supplement to their lectures to provide students with opportunities to apply their knowledge, skills, and critical thinking (Rauen, 2001). It is vital for the students to be able to assess the situations and recognize the correct answers; however, they need to be able to evaluate the thinking process behind their decisions (Pithers & Soden, 2000). Simulations allow students to learn from harmless, self-generated feedback (Bernstein, Scheerhorn & Ritter, 2002) and assure that they have been exposed to uncommon conditions. Simulations promise to decrease possible inconsistencies in athletic training education (Hammond et al., 2002; Lowdermilk & Fishel, 1991; Satava, 2001).

Active learning is important for critical thinking to take place (Browne & Freeman, 2000). Using computer simulations forces students to become active learners and make decisions on their own. Based on the consequences students learn to view the material presented more critically. However, based on this study computer simulations do not evaluate the thinking process behind the decision making, and thus, should not be used as an evaluation tool for assessing critical thinking.

This study used the California Critical Thinking Skills Test (CCTST) to evaluate participants’ critical thinking. CCTST and Watson-Glaser Critical Thinking Appraisal (WGCTA) are the most frequently used instruments to evaluate critical thinking of
college students. However, based on Adams et al. (1999) research, CCTST reflects critical thinking abilities in allied health professions more accurately than CCTST. Mishoe and Hernlen (2005) recommended the use of a variety of different instruments for measuring comprehensive critical thinking in healthcare education. Thus, further study investigating critical thinking of athletic training students should use a variety of instruments.

According to Kulik and Kulik (1991), students’ performances on computer simulations peak in four weeks. However, athletic training students participating in this study completed the most computer simulations during the second week of self-directed learning, which might be possibly due to “Hawthorne Effect” (motivation to participate in a new treatment). However, their performances on computer simulations did not continue to change over the period of time. Their scores reached the peak at the end of the second week of the study on the NATABOC Mock Exam computer simulation.

Students’ cumulative grade point averages and grade point averages of athletic training classes do reflect on their ability to think critically. This positive finding shows higher education programs help students with critical thinking.

Students respond positively to computer assisted learning with increased motivation towards learning (Jeffries, 2001). Thirty-two of thirty-three students who were asked to participate actually finished the study. The one student did not participate due to not attending the institution at the time of data collection. All participants were enthusiastic to participate in the study and test their knowledge on computer simulations. Computer simulations are not part of the curriculum at this institution, many participants
responded with positive feedback to include computer simulations over a variety of subjects. Additional feedback given by participants was that they enjoyed completing computer simulations because it was something new and challenging. Many seniors stated that they approached these computer simulations as a preparation tool for their BOC exam. Junior level students expressed their interest in using computer simulations as their self-directed learning for the next year. Sophomore level students who were not involved in this study expressed their interest to participate in a similar study using computer simulations next year. Therefore, this study has generated a large amount of interest among athletic training students at this institution in using computer simulations as a learning tool.

Six out of seven (86%) seniors from the higher-level critical thinking group passed the BOC examination on the first trial. Two out of five (40%) from the lower level critical thinking group passed the BOC exam on the first trial. Future study may investigate the effect of critical thinking on students’ performances on the BOC examination.

**Recommendations for Further Study**

1. This study investigated the effect of computer simulations as a self-directed learning. It may be beneficial to athletic training education to investigate the effects of computer simulations on larger sample sizes from multiple institutions, using a variety of computer simulation instruments. Every athletic training program has some uniqueness and may differ slightly from others. Each computer simulation instrument varies in complexity and is designed
specifically to meet its goal (Jeffries, 2001; Mallott et al., 2005; Pattalachi, 2002).

2. Athletic training students are required to master many skills including evaluation, treatment, rehabilitation, administration, care and prevention, anatomy and physiology, biomechanics, etc. It would be beneficial for further studies to investigate the use of different subject matter computer simulations as a self-directed learning method. Participants of this study expressed interest in challenging computer simulations related to electrical modalities usage.

3. Several researchers (Brower, 2001; Draper, 1989; Harrelson et al., 1998 and Stradely et al., 2002) investigated learning styles among athletic training students. Based on Brower’s (2001) and Stradley’s et al. (2002) studies, there is equal distribution of learning styles among athletic training students. Students use different methods to learn and it is important for both the students and their instructors to recognize these methods and build on strengths and improve weaknesses to build a competent professional. Future studies in athletic training may want to investigate the effects of computer simulations as a self-directed learning on students with different learning styles.

4. Critical thinking is a necessity for healthcare professionals (Fuller, 1997; Miller, 1992; Rauen, 2001; Starkey et al., 2004). Future research should investigate athletic training students critical thinking levels with a large
sample of athletic training students from a variety of institutions. Each institution has a variety of instructors who may use different methods to teach critical thinking to athletic training students and provide insight to other educators.

5. Athletic training students are required to pass the BOC exam to become certified athletic trainers – healthcare professionals. Due to critical thinking being a necessity for athletic trainers’ futures (Erickson-Owens & Powell-Kennedy, 2001; Fuller, 1997; Starkey et al., 2004), research may want to investigate if the BOC exam reflects critical thinking of the applicants. The new hybrid format of BOC examination is to be reflective of critical thinking. Future research may want to investigate using some form of the hybrid exam compared to simulations.

6. Angel et al. (2000) and Pepa et al. (1997) suggested that critical thinking improves over time – a claim worthy of investigation. Therefore, future investigation may want to study the development of athletic training students’ critical thinking by implementing a longitudinal study collecting data on students’ levels of critical thinking and how they evolve from the freshman year to graduation.
REFERENCES


Jeffries, P. R. (2002). Designing, implementing, and evaluating simulations used as teaching strategies in nursing. *Nursing Educator Perspectives, 26*(2), 96-103.


February 5th, 2008

Dear Athletic Training Student,

My name is Marketa Schublova. I am a certified athletic trainer at [redacted] program and a doctoral student collecting data for my research collected as a fulfillment of my doctoral dissertation through Ohio University. I am seeking your assistance in collecting information for my dissertation project *The Effect of Computer Simulations Use as a Self-directed Learning Method of Physical Evaluation of Athletic Injuries*. I am interested in investigating the effect of computer simulation as a self-directed learning method on students’ performance on multiple-choice examination and computer simulation examination. For example, have you ever taken a multiple-choice examination testing your knowledge about a specific injury that you have worked with many times, however, the choices were confusing for you and couldn’t help you to express what everything you knew about the specific injury? Have you ever sat through a structured lecture knowing that you would learn better if you actively participated in computer problem-based simulation learning through trial and error and dealing with consequences? Everybody prefers a different way of learning. Athletic trainers need to be able to think critically while taking care of physically active. To make sure that we as educators prepare you athletic training students as close to real scenarios as possible we need to make sure that we provide you with realistic experiences and test your knowledge as close as possible to specific knowledge and skills necessary to become a certified athletic trainer professional. This study is investigating these relationships.

Your participation in this study is completely voluntary. You may withdraw from the study at any time. There are no known risks to you as a result of your participation. All material will be kept confidential and when the data are presented in a written report, it will be provided as group information. You can help by participating in this study. There are no individual benefits to you as a result of your participation. However, at the completion of the study, a copy of the overall results and your personal results will be provided to you.

You will take a multiple-choice exam and computer simulation exam at the beginning and at the end of the study. You will also be asked to complete California Critical Thinking Skills Test which will provide me and you with your critical thinking skills assessment. Over the period of 4 weeks you will have an unlimited access to computer simulations presented to you via the Internet. You will be asked to complete one simulation per week and your performance will be scored. You will be able to practice as many times as you wish and the computer will keep records of your performance and time you spent on each simulation.

I truly appreciate your participation and thank you for your time. If you have any questions, please feel free to contact me. If you have any questions about your right as a human subject, please contact the Ohio University Research Compliance Office at (740) 593-0664. Marketa Schublova, MS, ATC, CSCS

ms301903@ohio.edu, [redacted]
APPENDIX B: Informed Consent Form

CONSENT TO PARTICIPATE IN RESEARCH

Title of Research: The Effect of Computer Simulations Use as a Self-Directed Learning Method for Physical Evaluation of Athletic Injuries

Principal Investigator: Marketa Schublova, MS, ATC, CSCS
Principal Investigator’s Contact: marketa.schublova@___________
Department: ___________

Federal and university regulations require signed consent for participation in research involving human subjects. After reading the statements below, if you choose to participate in the study please indicate your consent by signing this form. The participation is voluntary and you may withdraw from the study at any time. Refusal to participate will involve no penalty or loss of any type of benefits to which you are otherwise entitled. You will be given a copy of the signed consent form to keep.

Explanation of Study
The purpose of this study is to investigate the effect of computer simulation usage as a self-learning method on undergraduate athletic training students' material retention regarding physical evaluation of athletic injuries. Athletic trainers need to be able to think critically. Do we as undergraduate athletic training educators promote this skill with our traditional assessment tests including multiple-choice exams?

The secondary topic of this study will investigate possible relationship between students' learning styles, critical thinking and their performances on a multiple-choice examination and a computer-simulation.

The proposition is that we as educators may be able to better understand the possible factors influencing the critical thinking of athletic training students during their undergraduate athletic training education and see the advantages/disadvantages of the use of computer simulations on undergraduate athletic training students' material retention of the physical evaluation of athletic injuries.
Procedures to be followed
At the beginning of the study you will be asked to complete Kolb’s Learning Style Inventory questionnaire on the internet website to provide the investigator with the information regarding your preferred learning style. You also will complete The California Critical Thinking Skills Test on the Internet with the intention to investigate your critical thinking skills. All of these results will be provided to the investigator and used later on in this study. You will be asked to take a 50 questions multiple-choice examination along with a computer simulation examination including material related to physical evaluation of athletic injuries. After completing all of these tests you will be given a username and password to the higherlevelthinking.com website. For following 4 weeks you will be asked to complete one computer-simulation per week. You will have an unlimited access and be able to practice these simulations as many times as you wish. All of your scores and number of completed simulations will be recorded and used for this study. After completing 4 weeks of self-directed computer-simulation learning there will be a multiple-choice and a computer-simulation exam administered to you and your scores will be compared to your previous tests scores you took at the beginning of this study. The principal investigator will obtain your AT-GPA (grade point average of classes required for athletic training major) along with grades for each of athletic training required classes and QPA (overall grade point average) from the university mainframe academic records and use this information in the study. Your confidentiality will be protected to the extent that is allowed by law. Your confidentiality will be protected by using your research ID number and only the investigator will have access to the raw data.

Duration of subject’s participation
There will be seven meeting sessions included in this study.

The first meeting session (45-60 minutes)
During this session the administrator will explain the purpose and procedures for this study. She will answer all participants’ questions, the Informed Consent Form and Subject’s Questionnaire will be distributed. This session will allow you to become familiar with the procedure and computer simulation software used in this study. You will be provided subject ID number that will be used throughout the study to ensure your confidentiality.

The second meeting session (40-50 minutes)
During this session you will take the Kolb’s Learning Style Inventory Questionnaire. This questionnaire will be administered via the Internet through Hay Group Transforming Learning’s website. Hay Group Transforming Learning is the division of the Hay Group organization that offers off-the-shelf assessment and development products and full-service diagnostics like the Inventory of Leadership Styles and Organizational Climate Survey. Hay Group Transforming Learning will evaluate your answers and provide the investigator with information regarding your preferred learning style which then will be used in this study. Your confidentiality will be protected by using your research ID number.
The third meeting session (40-50 minutes)
During this session you will take The California Critical Thinking Skills Test. This questionnaire will be administered via the Internet the California Academic Press’s website. The California Academic Press is an organization distributing publications and scoring of tests and survey instruments. The California Academic Press will evaluate your performance and provide the investigator with information regarding your critical thinking skills which then will be used in this study. Your confidentiality will be protected by using your research ID number.

The fourth meeting session (30-120 minutes)
During this session you will take the multiple-choice exam or computer-simulation exam depending on what group you will be randomly placed in. Both groups will take exactly the same tests only in different order. These exams include material related to physical evaluation of athletic injuries and your scores will be used as pre-test scores for comparison with similar test administered after 4 weeks of treatment.

The fifth meeting session (30-120 minutes)
During this session you will take the multiple-choice exam or computer-simulation exam depending on what group you will be randomly placed in. Both groups will take exactly the same tests only in different order. These exams include material related to physical evaluation of athletic injuries and your scores will be used as pre-test scores for comparison with similar test administered after 4 weeks of treatment that will follow this session.

The sixth meeting session (30-120 minutes)
During this session you will take the multiple-choice exam or computer-simulation exam depending on what group you will be randomly placed in. Both groups will take exactly the same tests only in different order. These exams include material related to physical evaluation of athletic injuries and your scores will be used as post-test scores for comparison with your pre-test scores.

The seventh meeting session (30-120 minutes)
During this session you will take the multiple-choice exam or computer-simulation exam depending on what group you will be randomly placed in. Both groups will take exactly the same tests only in different order. These exams include material related to physical evaluation of athletic injuries and your scores will be used as post-test scores for comparison with your pre-test scores.

Risks and Discomforts
There are no foreseen potential risks or discomforts in this study.

Benefits
You, as a participant in the study, will find out your preferred learning style and your critical thinking skills. You will be able to use your performance on the pre- and post-test in evaluation of your understanding of the physical evaluation of athletic injuries material. This may be a valuable practice tool for the BOC exam and help you to understand your potential limitations in specific topics.

Page 3 of 4 initials______
Confidentiality and Records
Confidentiality will be protected to the extent that is allowed by law. All of your information will be kept confidential and protected at all times through the use of number coding (your research ID number). All forms, survey questionnaires, and testing information will be securely stored in a locked filing cabinet in secured location in [redacted]. Only the primary investigator will be allowed access to this and all other information. At the termination of the study all information will be destroyed.

Compensation
No compensation will be offered to the participants in this study.

Contact Information
If you have any questions about the research study, you should contact the researcher at the telephone number listed at the top of this form. If you have questions about your rights as a participant in this study or the way the study has been conducted, you may contact [redacted] PhD, IRB Chairperson by telephone at [redacted] or by e-mail at irb@[redacted]

The participation in this research study is voluntary and if you choose you may withdraw without penalty at anytime. Refusal to participate will involve no penalty or loss of any type of benefits to which you are otherwise entitled. You will be given a copy of the signed consent form to keep.

I hereby consent to participate in this research study. I understand that I will receive a copy of this form once dated and signed.

Participant's Signature ___________________________________ Date ________________

Participant’s Printed Name ___________________________________

Investigator’s Signature ___________________________________ Date ________________

Investigator’s Printed Name ___________________________________

Page 4 of 4
APPENDIX C: Subject’s Questionnaire

1. Student ID: _____________________
2. Gender: ______ Female ______ Male
3. Age: __________________________
4. Class level: ____________________
5. Amount of clinical hours: __________ upper extremities
                      __________ lower extremities
6. Grade in Physical Evaluation of Athletic Injuries Class: _______ Credits: ______
7. Grade in Intro to Athletic Training Class: _______ Credits: ______
8. Grade in Applied Anatomy Class: _______ Credits: ______
9. Grade in Care and Prevention of Athletic Injuries Class: _______ Credits: ______
10. Grade in Integrative Approach I Class: _______ Credits: ______
11. Grade in Anatomy and Physiology I Class: _______ Credits: ______
12. Grade in Integrative Approach II Class: _______ Credits: ______
13. Grade in Anatomy and Physiology II Class: _______ Credits: ______
14. Grade in Therapeutic Modalities Class: _______ Credits: ______
15. Grade in Therapeutic Exercise Class: _______ Credits: ______
17. QPA _________

To be filled out by the researcher:

  Critical thinking results: ____________________________

  AT- GPA ______________________

  QPA __________________________
APPENDIX D: The California Critical Thinking Skills Test

Copyrighted material, please contact the following address for information and copies of the test.

California Academic Press
217 La Cruz Avenue
Millbrae, CA 94030
(650) 697-5628
http://www.insightassessment.com/
APPENDIX E: Practice Computer Case Studies

Copyrighted material, please contact the following address for information and copies of the test.

Ericka Zimmerman, MS, ATC
Program Director and Department Chair/
Coordinator of Clinical Education

University of Charleston, WV
Phone: 304-357-4828
erickazimmerman@cc.ucwv.edu
APPENDIX F: Computerized-Traditional Athletic Training Simulation Instrument

Copyrighted material, please contact the following address for information and copies of the test.

Dr. Ray Castle
Assistant Professor
Director - Athletic Training Education Concentration
Louisiana State University
Department of Kinesiology
112 Long Field House
Baton Rouge, LA 70803-7101
Phone: 225-578-7175
FAX: 225-578-3680 rcastl1@lsu.edu
APPENDIX G: Testing Site IRB Approval

TO: Ms. Marketa Schublova
FROM: Interim Chairperson, Institutional Review Board (IRB)
DATE: November 28, 2007

The Institutional Review Board (IRB) of [University] has determined that the above-referenced protocol is exempt from IRB review, effective November 28, 2007 under exemption “a” that states:

“Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special educational instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.”

Good luck with your research and please contact the IRB at [Contact Information] or via e-mail [Contact Information], should your protocol change in any way.
A determination has been made that the following research study is exempt from IRB review because it involves: Category 1 research conducted in established or commonly accepted educational settings, involving normal educational practices

Project Title: The Effect of Computer Stimulations Use as a Self-Directed Learning Method for Physical Evaluation of Athletic Injuries in Undergraduate Athletic Training Education Program at Slippery Rock University of Pennsylvania

Project Director: Marketa Schublova
Department: Teacher Education

Advisor: Ralph Martin

Robin Stack, C.I.P., Human Subjects Research Coordinator
Office of Research Compliance

Date
The approval remains in effect provided the study is conducted exactly as described in your application for review. Any additions or modifications to the project must be approved by the IRS (as an amendment) prior to implementation.