

THE RELATIONSHIP AND PREDICTIVE POWER OF CRITICAL THINKING SKILLS  
SCORES TO NATABOC CERTIFICATION EXAMINATION FOR ATHLETIC TRAINING  
PERFORMANCE SCORES

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Doctor of Education

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By  
DAVID E. COLT  
Phillip E. Messner, Dissertation Supervisor  
DECEMBER 2007

The undersigned, appointed by the Dean of the Graduate School, have examined the dissertation entitled

THE RELATIONSHIP AND PREDICTIVE POWER OF CRITICAL THINKING SKILLS  
SCORES TO NATABOC CERTIFICATION EXAMINATION FOR ATHLETIC TRAINING  
PERFORMANCE SCORES

Presented by David E. Colt

A candidate for the degree of Doctor of Education,

and hereby certify that, in their opinion, it is worthy of acceptance.

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Phillip E. Messner, Chair

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Frank D. Grispino, Member

---

Michael W. Graham, Member

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Rochelle L. Hiatt, Member

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Max Ruhl, Member

## DEDICATIONS

I dedicate this dissertation to the most important people in my life, my parents and my wife and my family. I don't know how I'd be where I am today without all of you. Mom and Dad, thank you for teaching all four of your children the value of hard work and doing the best we can at all times. You never pushed us to do anything except the best we could do in whatever we wanted to do. I'll always remember that a job worth doing is worth doing right. I'll also always remember and cherish the advice to find a good woman in church, not the bars. My wife, Susan and I met in a Sunday school class at the First United Methodist Church in Maryville, MO. She quickly became my soul mate and my partner in life. Through the ups and downs of life, including her treatment for cancer during my doctoral studies, she has remained by my biggest supporter, encourager and love of my life. When I start to think I'm tough, I just look to her and see a real fighter and a survivor. She knows what it's like to make her way through the tough times and my spirit grows because of her. She has taught me so much and I thank God for putting her in my life. My efforts during the past 7 years are nothing compared to hers. Thanks Susan – I'm enjoying growing old with you, let's continue to take our time doing it! Derek and Carissa, thanks for being such good kids and making fatherhood fun. You are joys in my life and I am extremely proud of both of you.

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# THE RELATIONSHIP AND PREDICTIVE POWER OF CRITICAL THINKING SKILLS SCORES TO NATABOC CERTIFICATION EXAMINATION FOR ATHLETIC TRAINING PERFORMANCE SCORES

David E. Colt

Dr. Phillip E. Messner, Dissertation Supervisor

## ABSTRACT

The purpose of this non-experimental descriptive study was to examine the relationship and predictive power of critical thinking skills scores to National Athletic Trainers' Association Board of Certification examination for athletic training (CE) performance scores. The California Critical Thinking Skills Test form 2000 (CCTST-2000) was used as the measure of critical thinking skills to determine if differences existed in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE.

The independent variables for the study were the CCTST-2000 total score and the five CCTST-2000 subscale scores of analysis, evaluation, inference, inductive reasoning, and deductive reasoning. The dependent variables were CE performance scores. CE scores were reported as passing or not passing the CE as well as the written, practical, and written simulation section scores.

Data were analyzed using the following statistical analysis procedures: Cronbach's Alpha, descriptive statistics, independent  $t$  test, Pearson Correlation, multiple stepwise regression, and discriminant analysis. Cronbach's Alpha was employed to establish reliability and internal consistency of the CCTST-2000. Independent  $t$  testing determined differences in athletic training certification candidate CCTST-2000 subscale and total mean scores between candidates that passed compared to those who did not pass the CE. Pearson Correlation determined the strength of correlation between CCTST-2000 scores and CE scores. Multiple

stepwise regression was used to determine if CE scores could be predicted based on CCTST-2000 total and subscale scores as well as determine if passing or not passing the CE could be predicted based on CCTST-2000 total and subscale scores. Discriminant analysis was employed to determine if the CCTST total score or any of the five CCTST subscale scores predict a candidate's ability to pass or not pass the CE.

Cronbach's Alpha revealed the reliability of the CCTST-2000 with a satisfactory level of internal consistency. Independent *t* testing determined that those candidates passing the CE had higher overall critical thinking skills and higher scores in the subscale areas of inference and deductive reasoning. It was determined by Pearson Correlation that correlations existed between:

1. CE written section scores and CCTST-2000 total score and inference and deductive reasoning subscale scores.
2. CE written section scores and CCTST-2000 inductive reasoning subscale scores.
3. CE practical section scores and CCTST-2000 inference and deductive reasoning subscale scores.
4. CE written simulation scores and CCTST-2000 inference and deductive reasoning subscale scores.

It was determined by multiple stepwise regression that written and practice section scores increased when deductive reasoning scores increased while written simulation scores increased when inference subscale scores increased. Finally, discriminant analysis generated one significant function that predicted success in passing the CE by having higher inference subscale scores and lower inductive reasoning scores. Conversely, lower inference subscale scores and higher inductive reasoning score predicted not passing the CE

## CHAPTER ONE

### INTRODUCTION TO THE STUDY

The following study was designed to determine whether there is a relationship and predictive power of critical thinking skills scores to National Athletic Trainers' Association Board of Certification Examination for Athletic Trainers (CE) performance

scores. The California Critical Thinking Skills Test (CCTST) was used as the measure of critical thinking skills to determine if differences existed in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE. This chapter will provide background information, conceptual underpinnings for this study, the statement of the problem, the purpose of the study, research questions and research hypotheses, the anticipated benefits of the study and limitations of the study, and definitions of key terms used in the study.

#### *Background*

The process for becoming a certified athletic trainer takes several years to complete. A college student begins by making application and being accepted into an athletic training education program accredited by the Commission on Accreditation of Athletic Training Education (CAATE). Upon graduation from the accredited program, the athletic training student becomes a candidate for certification and qualified to sit for the National Athletic Trainers' Association Board of Certification (BOC) Certification Examination (CE). Upon passing the CE and fulfilling all other requirements, the candidate is considered a certified athletic trainer (ATC). The CE is difficult to pass as

evidenced by a passing rate of 26.24% of first time test takers passing the entire CE in 2005 (BOC, 2006).

The CE consists of three sections. The written section consists of 150 multiple-choice questions with four choices per question and is designed to test the candidate's knowledge in the profession of athletic training. The practical section requires candidates to demonstrate various psychomotor skills required of an athletic trainer. The written simulation section requires the candidate to solve eight separate problems an athletic trainer might encounter. The written simulation is designed to test the candidate's decision-making abilities, and requires critical thinking and problem solving skills, as well as the ability to interpret the question correctly.

A candidate must pass all three sections of the CE to pass the exam. The success rate for first time exam candidates passing all three sections of the exam has been an average of 35.04% during a five year period from 2002 – 2006 (BOC <http://www.bocatc.org/resources/REPORTS/> 2007). If a candidate fails one or more sections of the exam, the failed section(s) may be retaken. The success rate declines for individuals taking the exam multiple times (BOC, 2007). Success on the exam is currently an issue that concerns many educators and students. A student unable to pass the exam is unable to become a certified athletic trainer. While there is no limit to the number of times a candidate may sit for the CE, some eventually give up after many trials.

Erickson and Martin (2000) found the highest ranked factor perceived to contribute to initial success on the CE was the candidate's ability to interpret the question correctly. Among other perceived contributors to success were; an active role in the

overall care of athletes, integration of cognitive, psychomotor, and affective competencies and skills into the daily experience, critical thinking skills, and problem solving skills. Rubinstein and Firstenberg (1987) stated ability in problem solving is dependent on thinking skills and knowledge.

The process of interpreting a question as well as problem solving requires an individual to think critically. Critical thinking skills seem to permeate test taking ability, ability to pass tests similar to the CE, and make good professional judgments. The allied health fields, in particular nursing (Bell, Heye, Campion, Hendricks, Owens & Schoonover, 2002; Bowles, 2000), are becoming more judgment oriented with critical thinking becoming a bigger issue. The profession of athletic training is no different. In fact, the ability to make good, sound professional judgments is essential to properly perform the duties of an athletic trainer. Failure to make sound professional judgments will likely cause physical harm to an athlete, possibly even death.

To date, no studies have been performed to evaluate the impact of critical thinking skills upon candidate success on the CE. If critical thinking skills are a contributor to success on the exam, as perceived by Erickson and Martin, faculty members of athletic training education programs must take these skills into account when developing their course syllabi and include the development of critical thinking skills as a part of the curriculum (Erickson & Martin, 2000). Also, if true, students interested in the athletic training profession should become aware of the need to develop their own critical thinking skills and consider entering a profession that does not require critical thinking if they do not have the disposition to develop the necessary skills.



### *Conceptual Underpinnings*

The roots of critical thinking and the desire to teach students how to reason well go back as far as Socrates' desire for truth and deep questioning for meaning, justification, or logical strength of a claim and Aristotle's concern for logic, rhetoric, and assertability (Paul, 1990). Many have attempted to define critical thinking or describe the characteristics of a good critical thinker (Chaffee, 1992; Dewey, 1964; Facione, Facione, and Giancarlo, 1997; Glasser, 1985; Gray, 1993; Kurfiss, 1988; Mayfield, 1987; Meyers, 1987; Paul, 1990).

The profession of athletic training requires the individual athletic trainer to make professional judgments often in high stakes, high stress situations that are sometimes life-threatening. Athletic training is an allied health profession that requires daily assessment of injury and decision-making (BOC, 2004). It is not unlike other health care professions in that the athletic trainer is presented with a situation or problem by a patient and expected to analyze the problem to come to a solution. Athletic trainers face situations in a variety of settings from football stadiums filled with thousands of spectators to the quiet of an athletic training room or examination room of a hospital based sports medicine clinic. As defined by Tabor (2005), an athletic trainer is:

“A person who has completed educational and clinical experiences and is capable of working with athletes and others involved in strenuous physical activity and their environment to help prevent injuries, advise them concerning appropriate equipment, recognize and evaluate injuries, administer emergency treatment, determine if specialized medical care is required, and rehabilitate those with injuries. In many instances, the first member of the health care team an injured

athlete encounters is an athletic trainer, who must be able to provide the best possible treatment. Athletic trainers work under the supervision of licensed physicians. In most states, athletic trainers must be licensed to practice” (p. 193).

Health care professions, athletic training included, require practicing professionals to utilize critical thinking to resolve problems presented on a daily basis. Health care professionals, when presented with a health problem, must take a medical history and attempt to determine the mechanism of the injury or illness. After determining the history and mechanism, the health care professional will then proceed to perform a physical assessment of the problem and attempt to come to a conclusion. Upon reaching a conclusion, a decision must be made concerning treatment, referral to physician, or other disposition of the patient. There are several health care professions that perform assessments, with nursing possibly being the closest to the athletic training profession in regard to assessment. Assessments require a systematic approach to solving the problem. Critical thinking is an important ingredient in a systematic approach to solving problems, especially those problems based in health care and science (Kenimer, 2002).

Nurses and athletic trainers perform their duties under the supervision of a physician, both are licensed or registered by individual states, and both deal directly with the patient population. While nurses generally work in hospitals or doctors’ offices, the profession has expanded into a wide variety of specialties (Nursing Spectrum, 2004). Athletic trainers primarily work in the athletic world with professional teams or those associated with educational institutions (either high schools or colleges). An increasing number of athletic trainers also work in the hospital or sports medicine clinic setting and treat injuries in the general population (NATA, 2007). Nurses and athletic trainers often

see the patient prior to the physician when an emergency or acute injury/illness arises; nurses in the emergency room and athletic trainers on the athletic field or court.

Written material concerning critical thinking and the nursing profession is abundant (Albert, Albert & Radsma, 2002; Bell, Heye, Campion, Hendricks, Owens & Schoonover, 2002; Bowles, 2000; Myrick, F., 2002). The necessity of a nurse and his or her ability to think critically has been well documented (Ignatavicius, 2001). In contrast, there is limited research available relating critical thinking and athletic training. To date, studies regarding critical thinking and athletic training involve curriculum design to include development of critical thinking skills (Heinrichs, 2002), critical thinking predisposition among athletic training students (Leaver-Dunn, Harrelson, Martin & Wyatt, 2002), and the effect of institutional control on critical thinking abilities of athletic training students (Stecyk, 2004). It appears the nursing profession has been extremely active in its pursuit of the inclusion of critical thinking in education programs as it relates to patient care.

### *Critical thinking*

The consensus statement regarding critical thinking created by a panel of experts during a Delphi research project sponsored by the APA is, “Critical thinking is the process of purposeful, self-regulatory judgment. This process gives reasoned consideration to evidence, context, conceptualizations, methods, and criteria.” (APA Delphi Report as quoted in Facione, 1998, p. 12).

Critical thinking consists of six core skills of a cognitive nature; analysis, interpretation, inference, evaluation, explanation, and self-correction (Facione, Facione, & Giancarlo, 1997). Analysis, interpretation, inference, and evaluation are used in

conjunction with each other by the critical thinker to form an opinion about an issue, while explanation and self-correction describe a justification for the opinion and an opportunity to alter the opinion.

### *Statement of the Problem*

A high failure rate exists for first time candidates sitting for the CE. An understanding of how critical thinking skills affect the success rate for passing the CE is lacking. Although professionals understand that critical thinking skills are important, there have been no studies performed to determine the relationship between critical thinking skills and candidate scores on the CE. Therefore, it was important to investigate the relationship between critical thinking skills and scores on the CE to inform and better prepare athletic training education program directors, faculty, and students to address the challenge of passing the CE.

### *Purpose of the Study*

The purpose of this study was to determine whether there is a relationship and predictive power of critical thinking skills scores to CE performance scores. The California Critical Thinking Skills Test (CCTST) was used as the measure of critical thinking skills to determine if differences existed in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE.

### *Research Questions*

RQ 1. Does the CCTST survey instrument have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha?

H<sub>0</sub>1: The CCTST survey instrument does not have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha?

RQ 2. What are the descriptive statistics of athletic training certification candidates CCTST subscale scores, total score, and CE section scores?

RQ 3. Is there a difference in athletic training certification candidate CCTST subscale and total mean scores between candidates that “pass” compared to those who do “not pass” the CE?

H<sub>0</sub>3: There is no significant difference in athletic training certification candidate CCTST subscales and total mean scores between candidates that “pass” compared to those who do “not pass” the CE ( $\alpha = < 0.05$ ).

RQ 4. Is there a correlation between athletic training certification candidate CCTST subscale and total scores, and CE section scores?

H<sub>0</sub>4: There is no correlation between athletic training certification candidate CCTST subscale and total scores and CE section scores.

RQ 5. Is there a multiple regression model for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores?

H<sub>0</sub>5: There is no multiple regression model for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores.

RQ 6. What CCTST subscales best discriminate between athletic training certification candidates that pass and do not pass the CE.

H<sub>0</sub>6: There are no CCTST subscales that discriminate between athletic training certification candidates that pass and do not pass the CE.

### *Anticipated Benefits of the Study*

Benefits of the study will be to students, faculty, and program directors of CAATE Accredited Athletic Training Education Programs. Students and faculty will be able to discern if good critical thinking skills are necessary to pursue a career in the athletic training profession. Program faculty will be able to determine the importance of constructing class syllabi to improve critical thinking skills of athletic training students.

### *Definitions of Key Terms*

This study required the use of specific vocabulary. In order to clarify terminology, the following terms are defined.

*Athletic Training Student.* An athletic training student is a college student enrolled in an accredited athletic training education program.

*Candidate.* A candidate is an athletic training student who has registered to sit for the National Athletic Trainers' Association Board of Certification Examination for Certification for Athletic Training.

*BOC.* The National Athletic Trainers' Association Board of Certification, Inc. (BOC) is the recognized credentialing agency for the profession of athletic training. Originally a committee within the National Athletic Trainers' Association, Inc. (NATA), the BOC has evolved into a stand alone credentialing board. In 1982, the Board of Certification was granted administrative independence from the NATA and was accredited by the National Commission for Health Certifying Agencies (NCHCA). In 1989, the BOC became incorporated (NATABOC, Inc.), complete with its own constitution and by-laws, officers, and articles of incorporation. The move to become its own entity was essential to satisfy the credentialing accrediting agency. Today, the BOC

is accredited by the National Organization for Competency Assurance (NOCA) (BOC, 2007).

*CAATE.* The Commission on Accreditation of Athletic Training Education was created on June 30, 2006. Incorporated in October, 1991, as the Joint Review Committee on Education Programs in Athletic Training (JRC-AT) and the Committee on Accreditation under the Commission on Accreditation of Allied Health Education Programs (CAAHEP), CAATE is the accrediting agency for 360 professional athletic training education programs. The American Academy of Family Physicians (AAFP), The American Academy of Pediatrics (AAP), the American Orthopaedic Society for Sports Medicine (AOSSM), and the National Athletic Trainers' Association, Inc. (NATA), cooperate to sponsor the CAATE and to collaboratively develop the *Standards for Entry-Level Athletic Training Educational Programs* (CAATE, 2007).

*CE.* CE is the acronym used in this study to identify the BOC Certification Examination for Athletic Trainers.

*CCTST.* CCTST is the acronym for the California Critical Thinking Skills Test.

*Delphi Study.* "The Delphi Technique is a method of structuring the collective judgments of a group of experts, conducted through a series of sequential questionnaires, each containing summarized information from earlier responses" (Erickson & Martin, 2000, p. 134).

*NATA.* The National Athletic Trainers' Association (NATA) is the trade organization for athletic trainers in the United States. There are over 30,000 members representing athletic trainers in all work settings and all 50 states. There are also international members from Canada, Mexico, Japan, the United Kingdom, and Europe.

The NATA is governed by a ten member board of directors plus a president. The ten board members are chosen from each of ten districts dividing the United States. The president is elected bi-annually by the membership.

*RD.* RD is the acronym for the role delineation study performed every five years by the BOC. The RD serves as the blueprint for the BOC Certification Examination for Athletic Trainers. It defines the roles of the certified athletic trainer.

#### *Limitations of the Study*

The following factors were limitations to the study.

1. The atmosphere for taking the CCTST was not controlled by the primary investigator. Individual athletic training program directors administered the CCTST at a time and location convenient for themselves and their students. It was possible for one program director to encourage students to do as well as possible, while another might not provide the same encouragement. Some testing facilities could have been a comfortable environment, while others could have been either warm or cool.
2. The truthfulness of the participants' answers on the CCTST was not controlled, thus the CCTST scores could affect the reliability of the study.
3. Although the CCTST and CE are reported to be reliable, the study is limited to the reliability of the testing instruments.



### *Delimitation of the Study*

The study participants were exclusively senior students enrolled in an accredited athletic training education program and registered to sit for the CE for the first time.

### *Summary*

This study will examine the correlation of athletic training certification candidate scores on the CCTST to scores on the CE. The study will also determine if a significant prediction model exists for scores on the CCTST and scores on each of the three sections of the CE. The internal consistency and reliability of the CCTST will be determined. Measures of central tendency and differences in mean scores on the CCTST and the ability to pass the CE will be determined.

## CHAPTER TWO

### REVIEW OF RELATED LITERATURE

The problem statement introduced in Chapter One focused on the lack of research regarding the relationship of critical thinking skills to candidate scores on the National Athletic Trainers' Association Board of Certification (BOC) Certification Examination (CE). The purpose of this study was to determine whether there was a relationship and predictive power of critical thinking skills scores to CE performance scores. The California Critical Thinking Skills Test - 2000 (CCTST-2000) was used to determine if differences exist in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE. This study then examined the relationship between scores on the California Critical Thinking Skills Test (CCTST) on each individual section of the CE as well as determined if there was a significant difference between scores of candidates that passed and did not pass the CE. Chapter Two will connect the current body of literature to the issues presented in Chapter 1.

#### *History of Critical Thinking*

The roots of critical thinking and the desire to teach students how to reason well go back as far as Socrates' desire for truth and deep questioning for meaning, justification, or logical strength of a claim (Paul, 1990). According to Weil (2004) in order to build communities of learning, the use of Socratic questioning is vital to help oneself and others develop true and meaningful critical thinking. Dewey (1974) outlined the attitudes of being open-minded, whole-hearted, and intellectually responsible as necessary for what he referred to as reflective thinking to occur. Dewey described open-mindedness as a freedom from prejudice and partisanship. Open-mindedness is a genuine

willingness to explore ideas and question. To be open-minded, one must be willing to discuss and listen to all sides of an issue and consider all possibilities no matter what their source. Whole-heartedness was described by Dewey as putting all of our energy and enthusiasm into learning something. The energy must be expended in learning, not in being distracted by outside influences. Intellectual responsibility is imagining the consequences of our thinking, being accountable for the consequences of our thinking, and insuring uniformity between our beliefs and our actions. Dewey is credited with coining the term, critical thinking (Facione, Facione, Blohm, & Giancarlo, 2002; Fuller, 1997). Dewey described how critical thinking was important to the development of a moral sensibility and the process of social reform (Kincheloe, 2004). Dewey stated that “education consists in the formation of wide-awake, careful, thorough habits of thinking” (Dewey, 1933, p 78 in Ruggiero, 1988, p 3).

Throughout time, philosophers and educators stressed the importance of thinking and reasoning over content. According to Mann (1979) as quoted in Bransford, Arbitman-Smith, Stein, & Vye (1985), Plato emphasized the importance of process and the mental discipline to reason and think over mere content. Also according to Mann (1979 in Bransford et al.), Francis Bacon, in the 1500’s, believed that students’ lack of attention would be corrected through study of mathematics. In the late 1600’s and early 1700’s, John Locke believed in the benefits of mental discipline, learning to work, and concentration of thought (Bennett & Bristol, 1906 as quoted in Bransford et al.). Further evidence of developing mental discipline and systematic analysis and process is found in America as universities such as Yale encouraged faculty to expand the mind’s powers by making students complete various daily exercises of the mind (Mann, 1979 in Bransford

et al.). Graham Wallas' book *The Art of Thought* (1926) argued that thought is an art and is one of the most important activities of human society (Ruggiero, 1988). Wallas believed that training thought should be part of every thinker's education. Victor Noll (1935) suggested, "Teachers who wish to develop habits of scientific thinking in their pupils must first of all set up these habits as definite goals of instruction. To assume that if we teach our subject matter well scientific thinking will result automatically, is sheer folly" (as quoted in Ruggiero, (1988, p. 4). Ruggiero claimed critical thinking is not subject-specific, but central to the approach to teaching no matter what the subject.

The decade of the 1980's provided the biggest explosion of scientific research and the development of what is known today as critical thinking. Studies related to athletic training have been minimal (Fuller, 1997; Stecyk, 2000; Leaver-Dunn, Harrelson, Martin, & Wyatt, 2002) while those related to nursing have been abundant. Since the professional duties of nurses and athletic trainers are similar in regard to assessment of injury and/or illness, decision-making processes, and patient care, this chapter will include references to the nursing studies as they pertain to critical thinking.

### *Definition of Critical Thinking*

Prior to a Delphi panel convened by the APA in 1990, there were many attempts at defining critical thinking. The lack of a clear definition appears to have hampered past discussions regarding critical thinking because people could not agree upon what is critical thinking. The lack of a clear definition also has hampered attempts to teach students the art of critical thinking as well as the development of improved skills in critical thinking.

Ennis (1993, p. 180) provided a simple, one sentence definition of critical thinking by stating, “critical thinking is reasonable and reflective thinking that is focused upon deciding what to believe or do”. Beyer (1995) provided the brief definition as making reasoned judgments. He argued that critical thinking is making a judgment of how reasonable and true anything is.

Paul (1990) was more elaborate with his definition, “critical thinking is disciplined, self-directed thinking which exemplifies the perfections of thinking appropriate to a particular mode or domain of thought” (p. 51). He included in his description of critical thinking, “the art of thinking about your thinking while you are thinking so as to make your thinking more clear, precise, accurate, relevant, consistent, and fair” (p. 32). Mayfield (1987) provided a definition of critical thinking by examining the Latin and Greek derivations of the word critical. He noted the word critical comes from the Latin root form skeri. Skeri means to cut, separate, or sift. Mayfield claimed the Latin idea conveyed is to take something apart and analyze it. In Greek, the root is the word kriterion, which means a judging for standard. Mayfield further combined the original ideas for critical means to analyze on the basis of a standard. He also stated thinking should be considered in the sense of conscious mental activity. Using the Greek and Latin word derivations, Mayfield concluded critical thinking is “consciously observing, analyzing, and evaluating according to a standard” (1987, p. 6).

In 1990, the American Psychological Association (APA) convened a Delphi panel to examine the issues and attributes of good critical thinking. A definition of critical thinking was developed in the form of a position statement by the panel. The APA Delphi

Report: Expert Consensus Statement regarding Critical Thinking and the Ideal critical thinker is as follows:

“We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one’s personal and civic life. While not synonymous with good thinking, CT is a pervasive and self-rectifying human phenomenon. The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers means working toward this ideal. It combines developing CT skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society” (Facione, 1990, p. 2).

Since the above consensus definition was established, research has been able to focus on the disposition of critical thinking and whether or not critical thinking can be taught or improved.

The upper levels of Bloom's Taxonomy can be viewed as somewhat of a description of what is critical thinking, from the lower level knowledge acquisition, through the understanding phase, to application and the higher order thinking that includes, analysis, synthesis, and eventually evaluation (Carr, 2007). At universities throughout the United States, freshman and sophomore classes attempt to build knowledge and understanding. As a student progresses, he or she will begin to apply the knowledge learned in the basic coursework and begin to analyze, synthesize, and evaluate. Athletic training education is no different. By the time an athletic training student is evaluating injuries, he or she will have already learned basic human anatomy and physiology (A & P). Exercise physiology will have forced the application of A & P and biomechanics will force analysis.

#### *Dispositions of a Good Critical Thinker*

McPeck (1981) noted that critical thinking has the dimensions of a frame of mind as well as various specific mental operations that must be followed with an inclination to ask questions. Fraser and West (1961) described the frame of mind as an awareness of the need to evaluate information, being willing to access options, and consider all viewpoints before coming to a conclusion.

Critical thinking dispositions can be divided into seven sub-categories. Without possessing these dispositions, the skills of good critical thinking will not be present. Individuals with good critical thinking dispositions are inquisitive, open-minded,

analytical, truth-seeking, self-confident, mature, and systematic (Facione, Sanchez, Facione, & Gainen, 1995).

### *Improvement of Critical Thinking*

O'Reilly (1985) claimed that critical thinking skills can be taught at the high school level by first teaching students how to be skeptical. He then described how to teach to identify and evaluate evidence. Students are then required to practice these skills in order to master them. Beyer (1985) also makes similar claims and provides a direct how-to approach.

Heiman (1985) presented a system developed by Whimbey and Lochhead to teach initially poor problem solvers to be increasingly more systematic in their thinking, thus improving critical thinking skills. Whimbey and Lochhead found, when initially poor problem solvers master skills of systematic problem analysis through a series of exercises, they are then able to transfer the learned skill to other learning situations. Bransford, et al. (1985) described in detail the step by step process Whimbey and Lochhead used in their short course in analytical reasoning. The Whimbey and Lochhead process attempted to teach students a complex set of skills that, if practiced, can be acquired. It appears systematic problem solving holds at least one key to becoming a good critical thinker and can be learned. Heiman described several other exercises which she employs to improve critical thinking.

Brookfield (1987) claimed that two central activities, used in groups, to develop critical thinking are identifying and challenging assumptions and exploring alternative ways of thinking and acting. Facilitators of the group must model openness and critical analysis, be encouraging of self-worth, listen closely to members of the group, and ask



challenging questions that do not intimidate. Critical thinkers must have a heightened awareness of how assumptions create perceptions, understandings, and interpretations. Once able to understand the assumptions, the assumptions can be and should be examined for accuracy and validity.

Brookfield also believed making people aware of their personal learning style will help develop critical thinking. Learning styles refer to an individual's method of dealing with knowledge (Colucciello, 1999). Coucciello concluded that an individual's learning preference is related to critical thinking dispositions and recommended a variety of methods that attempt to improve the critical thinking dispositions of nursing students. She suggested encouragement and mentoring in Kolb's reflective observation when taking on a task or problem in order to increase student self-awareness and self-confidence. Coucciello also suggested keeping reflective journals, Socratic questioning, problem-based learning methods using real life scenarios, and allocating time to reflect on experiences. She suggested opportunities to experience a variety of learning styles will assist in real life situations that will be encountered in the complex working situations of nursing.

Meyers (1986) explained students can be taught how to think critically. He claimed the biggest barriers are the attitudes and perspectives the students already have developed. Throughout the K-12 experience, students are taught concrete methods of learning. Students must alter their thinking to a more abstract process, one in which they "engage in what John Dewey called 'reflective thought'" (p. 27). Students must learn to hold off judgments and exercise an open mind and with skepticism toward a final conclusion. Students who think about thinking use higher order strategies to select and

monitor their mental operations and thus, facilitate critical thinking (APA Work Group, 1997). Methods of instruction that focus on developing higher order thinking strategies of students can facilitate learning and critical thinking (APA Work Group, 1997).

For example the profession of nursing has begun efforts to improve critical thinking of graduates of BSN programs through a post baccalaureate nurse residency program. The attempt to improve critical thinking utilizes case scenarios of complex clinical situations that have actually occurred (American Association of Colleges of Nursing, 2007). Athletic training programs are similar. Fuller (1997) reported that 13 athletic training program directors provided materials in a study that indicated athletic training educators fostered more CT in their learning objectives and written assignments than in their written exams.

### *Athletic Training Described*

Athletic training is an allied health care profession recognized by the American Medical Association, and has a history dating back to the Olympic Games in ancient Greece (Ebel, 1999). Athletic trainers are employed by high schools, colleges and universities, and professional teams to provide comprehensive health care to all athletes participating in team activities. Athletic trainers are also employed by hospitals and sports medicine clinics to provide physical rehabilitation to patients and health care coverage of local high school athletic departments (NATA 2007). Every five years the BOC conducts a role delineation study (RD) to identify essential knowledge and skills for the athletic training profession. The RD validates importance, criticality, and relevance to practice for both broad content areas and tasks of the athletic trainer. These tasks or roles are categorized and rubriced to provide a systematic document. The RD is used as the

blueprint instrument by the BOC for construction of the CE (BOC, 2007). The RD may be the single most important document the BOC uses for test construction as it ensures that the CE is content-valid. The six domain areas as defined by the RD are prevention of injury; clinical evaluation and diagnosis; immediate care; treatment, rehabilitation and reconditioning; organization and administration; and professional responsibility (BOC, 2007).

### *Prevention*

The RD defined prevention as, “the ability to discern, evaluate, and communicate risk associated with participation in athletic and physical activities” (BOC, 2004, p. 3). Any exposure to the chance of injury or a hazard can be defined as risk (BOC, 2004). To assist patients in successfully preventing injury and illness and provide the highest quality of care for the patient, the athletic trainer must understand and use preventive measures. The athletic trainer must possess a working knowledge of human anatomy and physiology, biomechanics, epidemiology and pathophysiology of common and catastrophic injuries and illnesses. There are nine specific tasks involved with prevention as defined by the RD. These tasks include education of the patient about risks associated with participation in physical activity and sports, interpretation of preparticipation and other relevant screening data, instruction about standard protective equipment, application of protective devices, identification of hazards, maintenance of clinical and treatment areas to ensure safety and sanitation, monitoring of participants and environmental conditions, facilitation of physical conditioning and design of programs to minimize injury risk, and facilitation of healthy lifestyles (BOC, 2004).

### *Clinical Evaluation and Diagnosis*

Clinical evaluation and diagnosis requires the athletic trainer to employ diagnostic reasoning and medical decision making (BOC, 2004). This area requires excellent critical thinking skills. Clinical evaluation and diagnosis can take place as part of a preparticipation evaluation to determine if possible medical conditions exist that might limit or endanger the patient. Clinical evaluation can also take place on the playing field following the occurrence of an acute injury, in the athletic training room or clinic as part of a more detailed evaluation, or as a progress evaluation to assess the progress of the rehabilitative process or to determine the ability of an athlete to return to play (BOC, 2004). Evaluation and diagnosis are a part of many medical professionals' daily duties. Physicians and nurses are probably the most closely related professionals regarding evaluation and diagnosis. During the process of evaluation of an injury or illness, the athletic trainer must take into account the mechanism of injury, history of the injury or illness, observation and inspection of the body part, palpation, results of special tests as well as the general health of the patient. Through the process, the athletic trainer must collect the described data, analyze the data, form a hypothesis, and come to a conclusion (BOC, 2004). The skills of good critical thinking are required throughout the process to insure the proper diagnosis and treatment recommendation or referral.

### *Immediate Care*

The area of immediate care focuses on the knowledge and skills required in an emergency situation. This area is unique to the athletic training profession (BOC, 2004). The athletic trainer is present at practices and conditioning sessions as well as games and events. No other health care professional is at the site of daily practice. Physicians and

EMTs or paramedics are often present at certain competitions (i.e. football games), but rarely are they present at a practice. Since most injuries occur in practice situations, the athletic trainer must be skilled in providing standard immediate care procedures. This could include life-saving techniques to reduce morbidity and the incidence of death, utilization of proper techniques to prevent further harm, timely transfer of care for conditions beyond the scope of practice of the athletic trainer, as well as establishing emergency action plans for the organization to follow in order to facilitate efficient immediate care of the injured or ill patient (BOC, 2004).

#### *Treatment, Rehabilitation and Reconditioning*

In conjunction with a licensed physician, the athletic trainer must determine appropriate treatment, rehabilitation, or reconditioning plans consistent with the clinical diagnosis. Plans must be constructed with consideration given to the age of the patient as well as general health, physical activity goals, and community and family healthcare support systems. One must treat the individual in all cases (BOC, 2004). Each athlete or patient will respond differently to a specific injury and will progress at a different rate with different complications along the way. It is the responsibility of the athletic trainer to understand and recognize these differences. It takes knowledge and skill to interpret and analyze the problem, develop a short term and long term plan of treatment and rehabilitation, and to assist in the restoration of function for the patient (BOC, 2004).

The athletic trainer is required to administer therapeutic and conditioning exercises or therapeutic modalities using standard techniques and procedures to assist the patient's recovery and return to function and performance at a level acceptable to the patient. Application of braces or other supportive devices, administration of treatment

regimes for general illnesses, and education of the patient with regard to the treatment, rehabilitation or reconditioning is also required. Reassessment and documentation of the status of the injury or illness is necessary to determine progress and/or the readiness of the athlete to return to participation (BOC, 2004).

### *Organization and Administration*

Organization and administration has been an area of growing responsibility for all health care professionals. With the enactment of the Health Insurance Portability and Accountability Act of 1996 (HIPPA) came increased necessity for medical record keeping and privacy. More forms and signatures are required of all professionals. In the profession of athletic training, organization and administration also requires detailed documentation of plans, policies, and procedures to ensure efficient operations within the BOC Standards of Practice and the NATA Code of Ethics. Plans and procedures for emergency preparedness, delivery of healthcare services, management of facilities and activity areas must be in place to promote timely care, promotion of safety, and for legal compliance (BOC, 2004). In addition to compliance with the HIPPA law, guidelines established by the Occupational Safety and Health Administration (OSHA) must be followed, just as in other medical professions. Maintenance of records, management of human and fiscal resources, and development of professional relationships to enhance delivery of healthcare services and meet legal responsibilities are of utmost importance (BOC, 2004).

### *Professional Responsibility*

The BOC through the RD also requires that athletic trainers comply with ethical, legal, and other professional standards to ensure protection of the public. More than

anything else, the BOC is a watchdog for public protection. The entire certification process, including the CE, revolves around making certain that a certified athletic trainer meets stringent minimal standards, and maintains those standards throughout his or her career. The athletic trainer must demonstrate appropriate professional conduct at all times by complying with applicable standards and maintaining competence by meeting continuing educational requirements set forth by the BOC (BOC, 2004).

### *Certification of the Athletic Trainer*

The National Athletic Trainers' Association Board of Certification (BOC) has been involved in certifying individuals since 1960 (BOC, 2007). The certification process is designed to demonstrate that the individual athletic trainer is qualified to perform the necessary duties without threat of harm to the public. The development of the CE is a complex process that begins with the Role Delineation Study (RD) and finishes with a three-part examination (BOC, 2004).

### *Certification Examination Construction*

The BOC has developed three sections of the CE, each measuring competence in a different area of functioning. The written section consists of 150 multiple-choice questions that measure basic knowledge of the profession of athletic training. The practical section asks candidates to perform psycho-motor skills and measures ability to perform the skillful duties of athletic training. Examples might include taping an ankle, performing an assessment test for a knee injury, or demonstrating the ability to properly fit a pair of crutches for a patient. The written simulation section measures the

candidate's ability to evaluate a situation and make decisions. Candidates are presented with written scenarios that might be encountered in actual practice. They are then asked to choose the appropriate action(s) from a list of several possibilities (BOC, 2007).

### *Content Validation*

The CE is content validated via a five step process, beginning with the RD. The initial step of the RD is developing the six domains of athletic training. The domains are then broken down into tasks. The tasks are then divided into knowledge areas and skills or abilities. Step 2 of the content validation process is development of the test blue print. The results of the RD determine the blue print which determines the content of the CE. Information regarding importance, criticality, and relevance of each domain and task is taken into account to determine the percentage of items to be included in the CE from each content area. Step 3 is item development. All items (questions or scenarios) are developed by certified athletic trainers or others employed in another allied health profession (i.e. physicians or physical therapists). The item development process is also complex, with each writer being trained in item development. Each item undergoes a process of being placed into a content category, assigned a cognitive level, and validated according to its appropriateness to an entry-level athletic trainer. Once an item has been developed, reviewed, validated, and accepted, it is then submitted for psychometric and editorial review. After the second review, it is entered into a bank for possible inclusion on a future test. Step 4 is the development of the CE. Each CE is created by selecting at random items from the item bank. The number of items from the various content areas is determined by the test blue print. Step 5 is examination review and revision. Each year, the CE is reviewed and revised by a committee to ensure the CE is a valid test of the



candidates' abilities. All items undergo statistical analysis. Inappropriate or questionable items are either revised or omitted from future exams. When an item is revised, it goes back through the validation process before being placed back into the item bank (BOC, 2007).

Internal consistency for the 2003-2004 testing years was determined using the KR-20 method. The KR-20 calculation for each version of the written section was .81, the four versions of the practical section ranged from .89 to .93, and the estimate for both versions of the written simulation section ranged from .89 to .91. These estimates suggest high reliability (BOC, 2007).

Each section of the CE is designed to test something different. Therefore, a low correlation should be expected among the three sections. The correlation between the written and written simulation sections was .43. The correlation between the practical and written simulation sections was .28 while the correlation between the practical and written sections was .44. These correlations suggest little overlap of the three sections (BOC, 2007).

#### *Certification Examination Passing Point*

The BOC uses the Angoff Modified Technique for setting the passing point of the CE. The Angoff Modified Technique is a criterion-referenced approach that relies on the pooled judgments of content experts. A group of judges, made up of certified athletic trainers, must answer the following question as it pertains to each question on the CE: "What is the probability that a minimally acceptable candidate will answer this item correctly?" The average of the proportions is then multiplied by the total number of questions on the exam. The result then represents the minimally acceptable score. The

final passing point for the exam is based on this pooled judgment and the calculation of the standard error of the mean (BOC, 2007).

The BOC routinely performs an item analysis for each question and reliability indexes are also calculated for each section of the exam. Each new exam version is equated to the initial or anchor version to ensure that candidates are not rewarded or penalized for taking different versions of the exam (BOC, 2007).

### *Critical Thinking and Nursing*

The profession of nursing is making attempts to develop critical thinking of nursing students as part of the curriculum of nursing schools. One of the criteria for accreditation by the National League for Nursing (NLN) requires each program to define critical thinking. While each program defines critical thinking in its own way, it must reflect student learning and thinking ability (Leppa, 1997).

Boyчук Duchscher (1999) claimed nurses face a challenge to make changes from using critical thinking as a problem solving technique to a process of reflective decision making. The critical thinking process is grounded in critical inquiry which identifies central issues, examines reasoning, challenges assumptions, explores value conflicts, and inquires into the clarity or ambiguity of the language that defines the problem. She further explained that clinical judgment necessary in nursing is rooted in the critical thinking process. Clinical judgment requires the nurse to interact with the patient by observation, evaluation of data, and taking action on behalf of the patient. Bowles (2000) demonstrated a positive correlation of the subscales of inference and inductive reasoning to clinical judgment in nursing. Clinical judgment of nursing is closely related to the clinical evaluation and diagnosis role of the athletic trainer.

In June, 2002, the University Health System Consortium (UHC) and the American Association of Colleges of Nursing (AACN) created a post baccalaureate nurse residency program to support graduate nurses as they transition into their first professional positions. The program has two phases. Phase two's primary goal is to enhance the critical thinking skills and the ability to use data to promote patient safety (American Association of Colleges of Nursing, 2002). The program follows some of the recommendations of Boychuk Duchscher by presenting case scenarios based on actual complex clinical situations that have occurred at participating hospitals.

Sheffer and Rubenfeld (2000) reflected upon the wide variety of definitions and descriptions of critical thinking and the lack of consensus on the meaning and application of critical thinking in nursing. They conducted a Delphi study with the goal of creating a definition of critical thinking in nursing. The consensus statement that was the result of the study was: "Critical thinking in nursing is an essential component of professional accountability

and quality nursing care. Critical thinkers in nursing exhibit these habits of the mind: confidence, contextual perspective, creativity, flexibility, inquisitiveness, intellectual integrity, intuition, open-mindedness, perseverance, and reflection. Critical thinkers in nursing practice the cognitive skills of analyzing, applying standards, discriminating, information seeking, logical reasoning, predicting and transforming knowledge" (p. 356).

This statement is an important step in the profession of nursing and nursing education as it has implications for nursing practice, education, and research. The common language developed allows for consistency in nursing curricula, professional

accreditation, collaboration, and assessment of critical thinking skills. Facione, Facione, & Giancarlo (1997) discussed the need to sharpen the cognitive capabilities and nurture habits of mind that alert students to opportunities to use thinking to resolve problems. This statement supports the nursing consensus statement that included cognitive skills and habits of mind as important for critical thinking. Profetto-McGrath (2003) suggested nurse educators must be knowledgeable about critical thinking skills and dispositions and methods to assess them. She stated that educators must use activities and strategies to develop critical thinking skills and dispositions that allow nursing students to become excellent critical thinkers. Strategies Profetto-McGrath suggested to foster critical thinking skills and dispositions include debate, reflective journals, Socratic questioning, research projects, and analytical and position papers. She stated critical thinking is the central component for excellence in nursing.

Paul and Heaslip (1995) analyzed how critical thinking and intuitive practice are related to expertise in nursing. They explained how intuitive practice requires reasoning about nursing knowledge and application of reflective, critical thought in practice situations. Nursing students who are taught with these principles will develop into reliable professionals with expertise in reasoning and capable of quality patient care. They explained that expertise in nursing requires the ability to utilize appropriate nursing knowledge and skilled judgments to deliver patient care, the intellectual capacity to adjust what is known to specific cases and the ability to reason things through and direct the mind in a way that is disciplined and effective in problem solving.

### *Summary*

The history of critical thinking goes back as far as Socrates. Socratic questioning is mentioned many times in the literature regarding critical thinking. There have been many attempts to define critical thinking with little agreement until the APA convened a Delphi panel in 1990. The Delphi panel, made up of experts in the field of critical thinking, created a consensus statement that served as a working definition as well as described the attributes of the ideal critical thinker. Several authors agree that critical thinking can be developed through proper education that includes a variety of exercises designed to challenge the learner to use critical thinking as a process.

Athletic training is a health care profession recognized by the AMA. Certification in athletic training is controlled by the NATA BOC. The BOC conducts a role delineation every five years to evaluate the current roles and tasks of an athletic trainer in practice. Some of the roles of an athletic trainer are closely related to the profession of nursing. The nursing profession has been working feverously to ensure nursing students develop good critical thinking dispositions and skills. The nursing profession recognizes the importance of good critical thinking as a process to provide safe and effective care for patients. The profession of athletic training has few studies regarding critical thinking and none that compare critical thinking skills scores with NATA BOC Certification Exam scores.

## CHAPTER 3

### RESEARCH DESIGN AND METHODOLOGY

This was a non-experimental descriptive correlation study to investigate the role of critical thinking skills in the success on the certification examination for athletic training. This study evaluated the relationship of critical thinking skills test scores and test scores on the National Athletic Trainers' Association Board of Certification (BOC) Examination for Certification in Athletic Training (CE).

#### *Statement of the Problem*

A high failure rate exists for first time candidates sitting for the CE. During the 2004 testing year, of all first time candidates, 35.44% of 2294 passed all three sections of the CE. Of those candidates who did not pass all three sections, 41.4% failed the written section, 39.35% failed the practical section, and 41.91% failed the simulation section (BOC, 2005). During the 2005 testing year of all first time candidates, 26.24% of 1890 passed all three sections of the CE. Of those candidates who did not pass all three sections, 53.33% failed the written section, 44.51% failed the practical section and 39.08% failed the written simulation section (BOC, 2006). During the 2006 testing year of all first time candidates, 46.89% of 2222 passed all three sections of the CE. Of those candidates who did not pass all three sections, 51.55% failed the written section, 32.03% failed the practical section and 39.09% failed the written section. Candidates might have failed one, two, or all three sections. When a candidate passes all three sections, he or she has passed the examination and is then awarded the title "Certified Athletic Trainer". An understanding of the importance of critical thinking skills upon the success rate for passing the CE is lacking. There have been no studies performed to determine any

correlation between critical thinking skills as measured by the Californian Critical Thinking Skills Test (CCTST-2000) and candidate scores on the CE. Understanding the relationship between critical thinking skills as measured by the CCTST-2000 and the scores on the CE is important to athletic training education program directors, faculty, and students. Program directors, as well as faculty, can make adjustments to curriculum based on knowledge of the correlation of critical thinking skills to the exam. If critical thinking is found to be an important factor in passing the exam, the faculty may find data from this study beneficial and begin to teach or develop critical thinking skills throughout the curriculum. They may also utilize critical thinking strategies in their teaching styles. Students with knowledge of critical thinking skills can set career based goals for improvement of critical thinking skill level.

#### *Purpose of the Study*

The purpose of this study was to determine whether there is a relationship and predictive power of critical thinking skills scores to CE performance scores. The California Critical Thinking Skills Test (CCTST) was used as the measure of critical thinking skills to determine if differences existed in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE.

#### *Research Questions*

RQ 1. Does the CCTST-2000 survey instrument have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha?

H<sub>0</sub>1: The CCTST-2000 survey instrument does not have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha?

RQ 2. What are the descriptive statistics of athletic training certification candidates CCTST-2000 subscale scores, total score, and CE section scores?

RQ 3. Is there a difference in athletic training certification candidate CCTST-2000 subscale and total mean scores between candidates that “pass” compared to those who do “not pass” the CE?

H<sub>03</sub>: There is no significant difference in athletic training certification candidate CCTST-2000 subscales and total mean scores between candidates that “pass” compared to those who do “not pass” the CE (Alpha = < 0.05).

RQ 4. Is there a correlation between athletic training certification candidate CCTST-2000 subscale and total scores, and CE section scores?

H<sub>04</sub>: There is no correlation between athletic training certification candidate CCTST-2000 subscale and total scores and CE section scores.

RQ 5. Is there a multiple regression model for athletic training certification candidate CCTST-2000 subscale and total scores that predicts CE section passing scores?

H<sub>05</sub>: There is no multiple regression model for athletic training certification candidate CCTST-2000 subscale and total scores that predicts CE section passing scores.

RQ 6. What CCTST-2000 subscales best discriminate between athletic training certification candidates that pass and do not pass the CE.

H<sub>06</sub>: There are no CCTST-2000 subscales that discriminate between athletic training certification candidates that pass and do not pass the CE.



### *Methodology*

This section will describe the research design, the selection process for participants of this study as well as data collection and analysis. A description of the two instruments used, the CCTST-2000 and CE, will also be included. It is important to note that the CE is used by many state regulatory commissions for the licensure of athletic trainers. To be eligible to sit for the CE, a candidate must graduate from an accredited athletic training education program. The Commission for Accreditation of Allied Health Education Programs (CAATE) is the accrediting agency for athletic training education programs. There are over 300 accredited programs in the United States and programs are found in every state from which participants were chosen.

#### *Research Design*

The research design was a non-experimental descriptive study to determine the relationship between athletic training certification candidate scores on the CCTST-2000 subscale and total scores to CE sections. Quantitative data were collected from the CCTST-2000 and the CE in athletic training. CCTST-2000 subscale and total scores were assigned as independent variables and CE section scores were assigned as dependent variables for statistical analysis.

#### *Participant Selection*

Eligible participants were limited to those students enrolled in their final term prior to graduation from a CAATE accredited undergraduate athletic training education program and registered to sit for the first time for the CE and scheduled to complete all three sections in April, 2007 as described in Chapter 2. A total of 124 participants were obtained for inclusion in the study.

A letter of inquiry was sent to 336 athletic training education program directors in the United States (See Appendix A). Program directors were asked to express their willingness to present the opportunity to participate in this study to their senior students who were registered to sit for the April, 2007 CE by completing a short information form. A total of 61 program directors responded in the affirmative that they would be willing to assist. Willing program directors were then sent an email asking exactly how many students would be willing to participate and registered to sit for the April 2007 CE. Students were offered the opportunity to volunteer to participate in a national study about critical thinking by a doctoral student who is a certified athletic trainer (see Appendix B). Per IRB requirements, all participation was strictly voluntary. A total of 38 program directors responded with a total of 200 eligible and willing students to participate. The exact number of CCTST-2000 exam booklets and answer sheets were then mailed to each program director to administer the CCTST-2000 to the volunteer students. Included in the mailing were a consent to participate form (see appendix B) and a consent form for the BOC to released the candidate's CE scores. A total of 27 program directors returned a total of 134 completed CCTST-2000 answer sheets and signed consent forms from willing students. Eleven program directors failed to return the CCTST-2000 answer sheets or returned them too late to be included in the study. Of the 134 students completing the CCTST-2000, 124 sat for all three sections of the CE and were included in the study.

#### *Instrumentation and Data Collection*

*The CCTST-2000.* The CCTST-2000 is a 34 item multiple-choice test of critical thinking skills. It is a 45 minute, timed test. It was developed by Insight Assessment/The

California Press in Milbrae, CA. The CCTST-2000 provides item contexts that are representative of the reasoning required to be a skillful critical thinker. Test takers are required to form reasoned judgments based on discursive textually presented information and to reason with information presented in various diagrams and charts. The CCTST-2000 presents critical thinking questions requiring the application of one's reasoning skills and focuses on the assessment of the core critical thinking skills of analysis, inference, and evaluation-explanation. Since all three core critical thinking skills are used in both inductive and deductive reasoning, the CCTST-2000 scoring system provided subscale scores for inductive and deductive reasoning as well as the three core critical thinking skills. Scores were provided for the subscales of inductive reasoning, deductive reasoning, analysis, inference, evaluation and total score. The total score was the sum of the subscales of analysis, inference and evaluation or the sum of inductive reasoning and deductive reasoning subscale scores. KR-20 Alpha range reported by California Press for the CCTST-2000 Form 2000 is from 0.78 to 0.84 (Insight Assessment, 2007).

*Subscales of the CCTST-2000.* Analysis as described by Paul & Binker (1990) is an examination in detail or to look deeper into an issue. Examination includes breaking the whole into parts, categorizing, labeling, and continually analyzing ideas, experiences, and judgments. As an element of thought, analysis is an on-going process that is required throughout. The panel of experts who wrote the APA consensus statement analysis defines analysis as, “to identify the intended and actual inferential relationships among statements, questions, concepts, descriptions, or other forms of representation intended to express belief, judgment, experiences, reasons, information, or opinions” (APA as quoted by P.A. Facione, 2004, p. 4).

Elder and Paul (2002) described the difference between inference and assumption and how our assumptions relate to our inferences. In order for people to maintain an open-minded approach to thinking, they must be able to see situations from more than one point of view. An inference is “a step of the mind, an intellectual act, by which one concludes that something is true in light of something else’s being true, or seeming to be true” (Elder and Paul, 2004, p. 34). An assumption is part of our belief system that we take for granted. “We assume our beliefs to be true and use them to interpret the world around us” (Elder and Paul, 2004, p. 34). We continually make inferences based on our assumptions of what we believe to be true. Understanding that our assumptions may or may not be true and understanding that our inferences may or may not be correct and logical based on our assumptions is what critical thinkers take into consideration. If one can bring this concept into a level of conscious realization, one will be able to consider more than one point of view and thus, be considered open-minded (Elder and Paul, 2004). The APA panel of experts says that inference is, “to identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to deduce the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation” (APA as quoted by P.A. Facione, 2004, p. 5).

The APA panel of experts said evaluation is, “to assess the credibility of statements or other representations which are accounts or descriptions of a person’s perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions or other forms of representation” (APA as quoted by P. A. Facione, 2004, p. 4).

Paul and Binker (1990) said that evaluation is determining the worth or quality of something. However, they also claim that evaluation is much more than simply stating a preference or considering judgments as direct observations without admission of the possibility of error. Paul and Binker (1990) consider a careful logic in the form of a systematic flow of questions to be asked. They first want to know what exactly is being evaluated. Then they want to know the purpose of the evaluation and if that purpose is legitimate. Assuming a clear and legitimate purpose, they then ask for relevant criteria or standards for the evaluation. They also ask if there is sufficient, relevant information to fulfill the purpose. Finally, they want to know if the criteria were applied accurately and fairly to the facts. They claim critical thinkers will follow such a logical process and uncritical thinkers will not.

Inductive and deductive reasoning are used as subscales because they divide CCTST items along a more traditional domain of reasoning. Deductive reasoning is based upon assuming that all the premises taken into account in making a decision are true. Deductive reasoning then considers it not logically possible for a conclusion to be false if all premises are true. Inductive reasoning allows us to infer that in familiar situations things are most likely to occur or to have been caused as we have come to expect. “Inference used to inform judgment by reference to perceived similarities or applications of examples, precedents, or relevant cases is inductive.” (Facione, 1990, p. 90). Therefore, inductive reasoning considers it unlikely that the conclusion is false if all the premises are true, but it is possible that it could be (Facione, 1990).

Mayfield (1987) described critical thinking traits as being related to inductive reasoning and deductive reasoning.

*The CE.* The CE is a three-part examination. The exam consists of a 150 multiple-choice written section, an 8 question practical skills section, and an 8 problem written simulation section. Each section is assigned its own passing point. When CE test scores for the study were reported by the BOC, Inc. the report included the passing point for the written section was 106, while the practical section passing point was 35 and the written simulation was 500.

*Certification examination construction.* The BOC developed three sections of the CE each measuring competence in a different area of functioning. The written section consists of 150 multiple-choice questions that measure basic knowledge of the profession of athletic training. The practical section asks candidates to perform psycho-motor skills and measure ability to perform the skillful duties of athletic training. Examples of practical section questions might include taping an ankle, performing an assessment test for a knee injury, or demonstrating the ability to properly fit a pair of crutches for a patient. The written simulation section measures the candidate's ability to evaluate a situation and make decisions. Candidates are presented with written scenarios that might be encountered in actual practice. Candidates are then asked to choose the appropriate action(s) from a list of several possibilities and work through the problem until completion. (BOC, 2007).

*Content Validation.* The CE was content validated via a five step process, beginning with the Role Delineation (RD). The initial step of the RD was developing the six domains of athletic training. The domains were then broken down into tasks. The tasks were then divided into knowledge areas and skills or abilities. Step 2 of the content validation process was development of the test blue print. The results of the RD

determined the blue print which determined the content of the CE. Information regarding importance, criticality, and relevance of each domain and task was taken into account to determine the percentage of items to be included in the CE from each content area. Step 3 was item development. All items (questions or scenarios) were developed by certified athletic trainers or others employed in another allied health profession (i.e. physicians or physical therapists). The item development process was also complex, with each writer being trained in item development. Each item underwent a process of being placed into a content category, assigned a cognitive level, and validated according to its appropriateness to an entry-level athletic trainer. Once an item was developed, reviewed, validated, and accepted, it is then submitted for psychometric and editorial review. After the second review, it was entered into an item bank for possible inclusion on a future test. Step 4 was the development of the CE. Each version of the CE was created by selecting at random items from the item bank. The number of items from the various content areas was determined by the test blue print. Step 5 was examination review and revision. The CE is reviewed annually and revised by a committee to ensure the CE is a valid test of the candidates' abilities. All items undergo statistical analysis. Inappropriate or questionable items are either revised or omitted from future exams. When an item is revised, it goes back through the validation process before being placed back into the item bank (BOC, 2007)

*Internal consistency for the CE.* Internal consistency for the 2003-2004 testing years was determined using the KR-20 method. The KR-20 calculation for each version of the written section was .81, the four versions of the practical section ranged from .89

to .93, and the estimate for both versions of the written simulation section ranged from .89 to .91. These estimates suggest high reliability (BOC, 2005).

Each section of the CE was designed to test something different therefore; a low correlation should be expected between the three sections. The correlation between the written and written simulation sections was .43. The correlation between the practical and written simulation sections was .28 while the correlation between the practical and written sections was .44. These correlations suggest little overlap of the three sections. (BOC, 2005)

*Certification examination passing point.* The BOC used the Angoff Modified Technique for setting the passing point of the CE. The Angoff Modified Technique is a criterion-referenced approach that relies on the pooled judgments of content experts. A group of judges, made up of certified athletic trainers, must answer the following question as it pertains to each question on the CE: “What is the probability that a minimally acceptable candidate will answer this item correctly?” The average of the proportions is then multiplied by the total number of questions on the exam. The result then represents the minimally acceptable score. The final passing point for the exam is based on this pooled judgment and the calculation of the standard error of the mean. The BOC routinely performs an item analysis for each question and reliability indexes are also calculated for each section of the exam. Each new exam version is equated to the initial or anchor version to ensure that candidates are not rewarded or penalized for taking different versions of the exam (BOC, 2005).

*Participant identification and confidentiality.* Each candidate for certification was assigned a candidate ID number by the BOC. Students volunteering to participate signed



a consent form to release the BOC exam scores for use in this study (see Appendix C). After receipt, consent forms were kept on file in a locked office until mailed to the BOC for score release. The student BOC candidate ID number was also used as the identification number on the CCTST-2000 answer sheet. Each program director was given a code number for their school. All students included this code number on the answer sheet for the purpose of reporting aggregate CCTST-2000 scores back to the school at the completion of the study. No scores were reported to schools with only one student participating. Completed CCTST-2000 answer sheets and signed consent forms were returned in a prepaid envelope via United States Postal Service. The completed CCTST-2000 answer sheets were then mailed by the author to Cal Press for scoring. After scoring, Cal Press returned the scores using the students' BOC candidate ID number as the only identifier. Consent to release CE scores was sent via United States Postal Service to the BOC.

After students completed all three sections of the 2007 CE, and consent forms were sent to the BOC, CE scores were received using the BOC candidate ID number as the only identifier. The exam scores were then matched to the scores from the critical thinking inventories by using the candidate ID numbers. All data were entered into Statistical Package for the Social Sciences (SPSS) Graduate Pack version 10.0 for statistical analysis. At no time was it possible to match a candidate ID number to a name or otherwise identify the research participants. The only match was the CCTST-2000 scores to the exam scores of the same ID number. The BOC reported individual scores for each of the three sections of the examination as well as the passing point for each section. Candidates passing all three sections of the CE were considered to have passed

the CE. Candidates that did not pass all three sections were considered to have not passed the CE.

### *Data Analyses*

Raw score data were entered into SPSS for statistical analysis. Cronbach's alpha was used to determine internal consistency and reliability of the CCTST-2000. Multiple stepwise regression analysis determined correlations. MANOVA determined discriminant analysis, independent T-test determined differences in CCTST-2000 mean scores and discriminant analysis was used to classify and predict groups into pass/fail.

The raw scores on each of the three sections of the CE were the independent variables and the subscores and total score from the CCTST-2000 were the dependent variable.

*Cronbach's alpha.* The CCTST-2000 was chosen as the instrument to measure critical thinking skills of study participants. To investigate the reliability of the CCTST-2000, Cronbach's alpha was used (Cronk, 1999). Reliability criteria for use in this study was 0.8. The results are presented in Table 1.

RQ 1

Table 1

*Cronbach's Alpha for CCTST-2000 Subscales and Total Score*

CCTST-2000 Subscale	Cronbach's Alpha
Deductive	
Inductive	
Analysis	
Inference	
Evaluation	
Total Score	

Note: Criteria = > 0.8

*Descriptive statistics.* Descriptive statistics of study participants CCTST-2000 subscale and total scores will be presented in Table 2. The descriptive statistics will show the number of participants, the mean, and standard deviation for each CCTST-2000 subscale and total score as well as each section of the CE.

RQ 2

Table 2

*Descriptive Statistics of Athletic Training Certification Candidates  
for CCTST-2000 Subscales, Total Score, and Certification Exam Sections*

CCTST-2000 SUBSCALE	N	Mean	SD
Deductive			
Inductive			
Analysis			
Inference			
Evaluation			
Total Score			
Certification Exam			
Written			
Practical			
Written Simulation			

*Independent t-test.* RQ 3 asks if there a difference in athletic training certification candidate CCTST-2000 subscale and total mean scores between candidates that “pass” compared to those who do “not pass” the CE. Using descriptive statistics and an independent *t*-test with significance =  $<0.05$ , results will be presented in Table 3 (Cronk).

RQ 3

Table 3

*Difference in Mean, SD, N, and t-test for Pass/Fail  
Groupings of Certification Exam*

	N	Mean	SD	T	df	p-value
Pass						
Fail						

Note: Significance =  $< 0.05$

*Pearson correlation.* The Pearson Correlation will be used to determine the strength of correlation between CCTST-2000 scores and CE scores will made by Pearson Correlation (Cronk). Subscales and total scores from the CCTST-2000 will be tested against section scores from the CE. Results of the correlation based on significance  $\leq 0.05$  will be presented in Table 4

RQ 4

Table 4

*Correlations between CCTST-2000 Scores and CE Scores*

Subscale	Written			Practical			Simulation		
	Pearson Correlation	Sig.	N	Pearson Correlation	Sig.	N	Pearson Correlation	Sig.	N
Deductive									
Inductive									
Analysis									
Inference									
Evaluation									
Total Score									

Note: Significance =  $< 0.05$

*Multiple stepwise regression.* A prediction model will be presented in Table 5. A multiple step-wise regression was utilized to determine if CE scores can be predicted based upon CCTST-2000 subscale and total scores (Cronk). Significance in this model will be  $\leq 0.05$ . Multiple regression also determined if passing or not passing the CE can be predicted based upon CCTST-2000 subscale and total score (Cronk) with results presented in Table 6. Significance for this prediction will also be  $\leq 0.05$ .

RQ 5

Table 5

*Summary of Model Summary, ANOVA & Coefficients Analysis Results*

Source	Beta	r.sq.	SEE	F	Sign.
Constant					

Note: Significance =  $< 0.05$

*Discriminant analysis.* Discriminant analysis will be used to determine if the CCTST total score or any of the five CCTST subscale scores predict a candidate's ability to pass or not pass the CE. A table will present results of eigenvalues and Wilks' lambda. Other tables will present: correlation coefficients and standardized function coefficients; a scale of function means for candidates that passed and did not pass the CE; classification results; and functions at group centroids.

RQ 6

Table 6

*Eigenvalues and Wilks' Lambda*

		Canonical	Wilks'			
Function	Eigenvalue	Correlation	Lambda	Chi-square	df	Sig.

RQ 6

Table 7

*Correlation Coefficients and Standardized Function Coefficients*

Correlation coefficients with		Standardized coefficients for discriminant functions
Discriminant function		

RQ 6

		X
-1.0		0
		1.0

Figure 1. Group Mean Functions of Candidates Passing and Not Passing the CE

RQ 6

Table 8

*Classification Results*

		Predicted Group Membership		
		Pass	Fail	Total
Original Count	Pass			
	Fail			
%	Pass			
	Fail			

RQ 6

Table 9

*Functions at Group Centroids*

Function
Pass/Fail
Pass
Fail

Summary

The CCTST-2000 was administered to senior athletic training students registered to sit for the April administration of the CE. CCTST-2000 answer sheets were sent to Insight Assessment for scoring. CE results were provided by the NATA BOC. Individual exam results were paired with CCTST-2000 results using the NBC number.

Cronbach's alpha calculated the internal consistency and reliability of the CCTST-2000. Descriptive statistics were calculated for the CCTST-2000 and CE. Independent *t*-test determined if a difference existed between candidates that passed and did not pass the CE and CCTST-2000 subscale and total scores. Pearson correlation

determined if a relationship existed between CCTST-2000 subscale and total scores and CE scores. Multiple regression determined if CE section scores, as well as passing or not passing, can be predicted by CCTST-2000 subscale and total scores.

## CHAPTER 4

### PRESENTATION AND ANALYSIS OF DATA

This study investigated the relationship between critical thinking skills, as measured by the California Critical Thinking Skills Test (CCTST), to candidate scores on the Certification Examination for Athletic Training (CE) administered by the National Athletic Trainers' Association Board of Certification, Inc. (BOC). The purpose of this study was to determine whether there was a relationship and predictive power of critical thinking skills scores to CE performance scores. The CCTST was used to determine if differences exist in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE.

This chapter will present a review of the research design, participant selection and provide statistical analysis of data. Each of six research questions will be stated along with the null hypothesis followed by tables and figures representing statistical findings as well as narrative analysis.

#### *Review of Research Design*

The research design was a non-experimental descriptive study to determine the relationship of athletic training certification candidate scores on the CCTST subscale and total scores to CE section scores. Quantitative data were collected from the CCTST and the CE in athletic training. CCTST subscale and total scores were assigned as independent variables and CE section scores were assigned as dependent variables for analysis purposes.



### *Participant Selection*

Participation was limited to those students enrolled in their final term prior to graduation from a CAATE accredited undergraduate athletic training education program and registered to sit for the first time for the CE and scheduled to complete all three sections in April, 2007 as described in Chapter 2. A total of 200 participants were selected for inclusion in the study. CCTST test booklets and answer sheets were sent to 38 program directors at universities in the United States that agreed to assist with data collection by administering the CCTST to students volunteering for inclusion in the study. A total of 27 program directors returned completed CCTST answer sheets in time for inclusion in data analysis for an overall total of 134 candidates completing the CCTST. Of the 134 candidates completing the CCTST, 124 of them sat for the CE. The total number of participants completing the CCTST and CE was 124.

### *Statistical Analysis*

This section will present analysis of data. Each of six research questions will be stated along with five null hypotheses. Analyzed data will be presented in figures and tables with findings discussed as they relate to each research question.

#### *Research Question 1*

Research question one was addressed utilizing Cronbach's Alpha to measure internal consistency of the CCTST. A table will be presented showing the number of cases, number of items and the alpha.

*RQ 1.* Does the CCTST survey instrument have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha?

H<sub>0</sub>1: The CCTST survey instrument does not have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha?

Cronk (1999) states that Cronbach's alpha is a measure of internal consistency.

Cronbach's alpha consists of a number of items that make up a scale designed to measure a single construct and determines the degree that all items measure the same construct.

Data from the CCTST were entered into SPSS and analyzed using Cronbach's Alpha.

Number of cases was 124 with six items calculated. The six items were CCTST total score and the five CCTST subscale scores of analysis, inference, evaluation, inductive reasoning, and deductive reasoning. With an Alpha of .9027, the CCTST was considered reliable with a satisfactory level of internal consistency. The Null was rejected.

Table 1  
*Cronbach's Alpha for CCTST Subscales and Total Score*

N of cases	N of items	Alpha
124	6	0.9

Note: Criteria=>.80

### *Research Question 2*

Research question two provided descriptive statistics summarizing athletic training certification candidate CCTST subscale scores, total score, and CE section scores. A total of nine histograms represent the mean, standard deviation, and number for the CCTST total score, each of the five CCTST subscale scores and each of the three CE section scores.

*RQ 2.* What descriptive statistics can be used to summarize athletic training certification candidates CCTST subscale scores, total score, and CE section scores?

The mean and standard deviation were computed for the CE and CCTST total and subscale scores (see Table 2). CCTST total score average was 17.2 (SD = 4.82). The

histogram in Figure 1 (see Appendix D) shows the frequency of CCTST total scores with a well balanced distribution of scores except for a relatively lower number of total scores of 22.5. Subscale scores of analysis average was 4.63 (SD = 1.31). The histogram in Figure 2 (see Appendix D) shows the frequency of analysis scores with a bell curve skewed slightly toward the high end of scoring. Inference score average was 8.19 (SD = 2.79). The histogram in Figure 3 (see Appendix D) shows a well balanced bell curve of the frequency of inference scores. Evaluation score average was 4.39 (SD = 2.09). The histogram in Figure 4 (see Appendix D) shows the frequency of evaluation scores with the bell curve skewed very slightly toward the lower end of scores. Inductive reasoning average score was 9.85 (SD = 2.59). The histogram in Figure 5 (see Appendix D) shows the frequency of inductive reasoning scores very slightly skewed toward the higher end of scoring. Deductive reasoning score average was 7.35 (SD = 2.82). The histogram in Figure 6 (see Appendix D) shows the frequency of deductive reasoning scores in a well balanced bell curve slightly skewed toward the lower end of scoring. CE scores for the written section averaged 106.52 (SD 11.96). The histogram in Figure 7 (see Appendix D) shows the frequency of written section scores. Due to one very low score, the bell curve has a slow rise on the lower side of the scoring frequency. The passing point for the written section was 106. Practical section scores averaged 36.11 (SD = 5.79). The histogram in Figure 8 (see Appendix D) shows the frequency of practical scores. Most of the scoring on this section appears to have occurred on the higher end of the frequency meaning most candidates, in general, scored better on the practical section. The passing point for the practical section of the CE was 35. Written simulation section scores averaged 516.81 (SD = 97.81). The histogram in Figure 9 (see Appendix D) shows the

frequency of written simulation scores with the bell curve skewed toward the higher end of scoring. The passing point for the written simulation section was 500.

Table 2

*Descriptive statistics of Athletic Training Certification Candidates  
CCTST Subscales, Total Score, and Certification Exam Sections*

CCTST SUBSCALE	N	MEAN	SD
Analysis	124	4.63	1.31
Inference	124	8.19	2.79
Evaluation	124	4.39	2.09
Inductive Reasoning	124	9.85	2.59
Deductive Reasoning	124	7.35	2.82
Total Score	124	17.2	4.82
<b>CERTIFICATION EXAM</b>			
Written	124	106.52	11.96
Practical	124	36.11	5.79
Written Simulation	124	516.3	97.81

The figures and table presented for research question two provided the descriptive statistics for CCTST subscales and total score as well as the scores on each of the three CE sections. Histograms provided a bell curve for each score and table 2 provides the number, mean and standard deviation.

### *Research Question 3*

Research question three explored differences in the mean scores of the five CCTST subscales and total score between candidates that passed compared to those that did not pass the CE. Tables will present independent *t* test results for differences in mean scores comparing candidates that passed compared to those that did not pass the CE as well as each of the three sections of the CE.

*RQ 3.* Is there a difference in athletic training certification candidate CCTST subscale mean scores and total mean scores between candidates that “pass” compared to those who do “not pass” the CE?

H<sub>0</sub>3: There is no significant difference in athletic training certification candidate CCTST subscales mean scores and total mean scores between candidates that “pass” compared to those who do “not pass” the CE (Alpha = < 0.05).

*CE.* The independent *t* test was applied to compare pass and not pass student samples (Cronk, 1999). The mean scores of the CCTST subscales and total scores of those that passed the CE and those that did not pass the CE are presented in Table 3. A significant difference between the means of three CCTST scores was found for: total score ( $t(122) = 2.614$ , 2-tailed  $p < .05$ ); the subscale of inference ( $t(122) = 4.503$ , 2-tailed  $p < .01$ ); and the subscale of deductive reasoning ( $t(122) = 3.610$ , 2-tailed  $p < .01$ ). No significant differences in mean scores of the subscales of analysis ( $t(122) = .383$ , 2-tailed  $p > .05$ ), evaluation ( $t(122) = .052$ , 2-tailed  $p > .05$ ), and inductive reasoning ( $t(122) = 1.001$ , 2-tailed  $p > .05$ ) were found.

These findings suggest candidates with higher critical thinking skills scores in the subscales of inference and deductive reasoning were more likely to pass the CE. Athletic training educators should be aware of this finding and utilize teaching methods that will improve student inference and deductive reasoning skills.

Table 3

*Results of Independent t Test Comparing CE Pass/Fail Groups on CCTST*

CCTST Score	Pass		Fail		<i>T</i>	2-tailed sig.
	Mean	SD	Mean	SD		
Total Score	18.67	5.54	16.37	4.17	2.61	0.01**
Analysis	4.67	1.41	4.59	1.26	0.38	0.70
Inference	9.58	2.94	7.39	2.38	4.50	0.00**
Evaluation	4.40	2.14	4.48	2.08	0.83	0.96
Inductive Reasoning	10.16	3.13	9.67	2.23	1.00	0.32
Deductive Reasoning	8.51	2.94	6.70	2.54	3.61	0.00**

Note: Significance = &lt; .05

Significance = &lt; .01\*\*

*CE written section.* An independent *t* test was computed comparing mean scores of those that passed the written section of the CE and those that did not pass the written section of the CE. As shown in Table 4, a significant difference between the means of three CCTST scores was found for: total score ( $t(122) = 3.677$ , 2-tailed  $p < .01$ ), and the subscales of inference ( $t(122) = 4.82$ , 2-tailed  $p < .01$ ), inductive reasoning ( $t(122) = 2.55$ , 2-tailed  $p > .01$ ) and deductive reasoning ( $t(122) = 3.901$ , 2-tailed  $p < .01$ ). No significant difference in mean scores of the subscales of analysis ( $t(122) = .563$ , 2-tailed  $p > .01$ ), or evaluation ( $t(122) = 1.81$ , 2-tailed  $p > .01$ ) were found.

In general, results suggest those candidates with higher critical thinking skills scores in the subscales of inference, inductive reasoning and deductive reasoning were more likely to pass the written section of the CE. Athletic training educators should be aware of this finding and utilize teaching methods that improve student critical thinking skills of inference, inductive and deductive reasoning.

Table 4

*Results of Independent t test Comparing CE Written Section on CCTST*

CCTST Score	Pass		Fail		<i>t</i>	2-tailed Sig.
	Mean	SD	Mean	SD		
Total Score	18.65	5.57	15.61	3.19	3.68	0.00**
Analysis	4.69	1.44	4.56	1.16	0.56	0.57
Inference	9.25	3.00	7.02	2.00	4.82	0.00**
Evaluation	4.71	2.16	4.03	1.97	1.81	0.07
Inductive Reasoning	10.40	3.02	9.24	1.86	2.55	0.01*
Deductive Reasoning	8.25	3.13	6.37	2.05	3.90	0.00**

Note: Significance = &lt; .05

Significance = &lt; .01\*\*

*CE practical section.* An independent *t* test was computed comparing mean scores of those that passed the practical section of the CE and those that did not pass the practical section of the CE. As shown in Table 5, a significant difference between means of the CCTST total score ( $t(122) = 2.16$ , 2-tailed  $p < .05$ ) and the CCTST subscale scores of inference ( $t(122) = 2.64$ , 2-tailed  $p < .05$ ) and deductive reasoning ( $t(122) = 2.50$ , 2-tailed  $p < .05$ ).

No significant difference in mean scores for: the CCTST subscales of analysis ( $t(122) = .430$ , 2-tailed  $p > .01$ ), evaluation ( $t(122) = 1.18$ , 2-tailed  $p > .01$ ), inductive reasoning ( $t(122) = 1.29$ , 2-tailed  $p > .01$ )

In general, these findings suggest those candidates passing the practical section of the CE had higher subscale scores of inference. Therefore, these findings further suggest that those candidates with higher subscale scores of inference were more likely to pass the practical section of the CE.

Table 5

*Results of Independent t Test Comparing CE Practical Section Pass/Fail Groups on CCTST*

CCTST Score	Pass		Fail		<i>T</i>	2-tailed
	Mean	SD	Mean	SD		Sig.
Total Score	17.81	5.12	15.82	3.76	2.16	0.03*
Analysis	4.66	1.35	4.55	1.22	0.43	0.67
Inference	8.62	2.96	7.21	2.11	2.64	0.01*
Evaluation	4.53	2.06	4.05	2.16	1.18	0.24
Inductive Reasoning	10.05	2.74	9.39	2.18	1.30	0.20
Deductive Reasoning	7.77	2.94	6.42	2.31	2.50	0.01*

Note: Significance = &lt; .05

*CE written simulation section.* An independent *t* test was computed comparing mean scores of those that passed the written simulation section of the CE and those that did not pass the written simulation section of the CE. As shown in table 6, a significant difference was found between means of the CCTST total score ( $t(122) = 1.964$ , 2-tailed  $p = .05$ ) and the CCTST subscale scores of inference ( $t(122) = 2.917$ , 2-tailed  $p < .01$ ) and deductive reasoning ( $t(122) = 2.416$ , 2-tailed  $p > .05$ ). No significant difference between the means were found for: the CCTST subscale scores of analysis ( $t(122) = -.475$ , 2-tailed  $p > .01$ ), evaluation ( $t(122) = .989$ , 2-tailed  $p > .01$ ) and inductive reasoning ( $t(122) = 1.033$ , 2-tailed  $p > .01$ ).

These findings suggest those candidates with higher subscale scores of inference and deductive reasoning were more likely to pass the written simulation section of the CE.



Table 6  
*Results of Independent t Test Comparing CE Written Simulation Section Pass/Fail Groups on CCTST*

CCTST Score	Pass		Fail		<i>T</i>	2-tailed Sig.
	Mean	SD	Mean	SD		
Total Score	17.83	4.86	16.07	4.59	1.96	0.05*
Analysis	4.59	1.24	4.70	1.44	-0.48	0.64
Inference	8.71	2.72	7.23	2.70	2.92	0.00**
Evaluation	4.53	2.12	4.14	2.04	0.99	0.33
Inductive Reasoning	10.03	2.70	9.52	2.39	1.03	0.30
Deductive Reasoning	7.80	2.77	6.55	2.77	2.42	0.02*

Note: Significance = < .05

Significance = < .01\*\*

*Summary of RQ 3.* Data analysis for research question three presents independent *t* test results comparing mean scores of the CCTST subscales and total scores of those that passed the CE and those that did not pass the CE. Tables present the mean, standard deviation, *t* and 2-tailed significance the of CCTST subscale and total scores comparing those that passed and did not pass the CE as well as each of the three sections of the CE. For each of the three CE sections independent *t* test analysis indicated a difference between the means of athletic training certification candidate CCTST subscale and total scores and CE section scores. The null hypothesis for research question 3 is rejected.

#### *Research Question 4*

Research question four examined whether a correlation existed between athletic training certification candidate CCTST subscale and total scores and CE section scores. Table 7 will present the statistical analysis of the Pearson correlation and any significant correlations found.

*RQ 4.* Is there a correlation between athletic training certification candidate CCTST subscale and total scores, and CE section scores?

H<sub>0</sub>4: There is no correlation between athletic training certification candidate CCTST subscale and total scores and CE section scores.

*CE Written section.* Cronk (1999) states that the Pearson correlation coefficient (Pearson  $r$ ) determines the strength of the relationship between two variables of interval or ratio scale and the relationship will be linear. Therefore, a Pearson Correlation was computed to determine the strength of relationship between CCTST scores and CE written section scores. A significant low-moderate positive correlation was found between CE written section scores and: CCTST total score ( $r(122) = .329, p < .01$ ), CCTST inference subscale score ( $r(122) = .390, p < .01$ ), and CCTST deductive reasoning subscale score, ( $r(122) = .398, p < .01$ ). A significant weak positive correlation was found between CE written section scores and CCTST inductive reasoning subscale score, ( $r(122) = .178, p < .05$ ). No significant correlation was found between CE written scores and CCTST analysis subscale score, ( $r(122) = .106, p > .05$ ), or CCTST evaluation subscale score, ( $r(122) = .170, p > .05$ ). In general, results suggest that the higher the CCTST total score and subscale scores of inference and deductive reasoning, the higher the candidate will score on the written section of the CE. Higher scores on the subscale of inductive reasoning also will produce higher written section scores on the CE, but with less certainty. In general, these results suggest a low-moderate relationship between CE written section scores and overall critical thinking skills and specifically the areas of inference and deductive reasoning. A weak relationship existed between CE written section scores and the area of inductive reasoning. There was no relationship between CE written section scores and the areas of analysis and evaluation.

*CE Practical section.* A Pearson Correlation was computed to determine the strength of correlation between CCTST scores and CE practical section scores. A significant weak positive correlation was found between CE practical section scores and CCTST inference subscale score, ( $r(122) = .247, p < .01$ ), and deductive reasoning subscale score ( $r(122) = .254, p < .01$ ). No significant correlation was found between CE practical section scores and CCTST: total score, ( $r(122) = .174, p > .05$ ), analysis subscale score, ( $r(122) = .059, p > .05$ ), evaluation subscale score, ( $r(122) = .033, p > .05$ ), and inductive reasoning subscale score, ( $r(122) = .046, p > .05$ ). In general, these results suggest a weak relationship between CE practical section scores and the critical thinking areas of inference and deductive reasoning. No relationship existed between CE practical section scores and overall critical thinking skills or the specific areas of analysis, evaluation, or inductive reasoning.

*CE written simulation section.* A Pearson Correlation was computed to determine the strength of correlation between CCTST scores and CE written simulation section scores. A significant weak positive correlation was found between CE written simulation section scores and CCTST: inference subscale scores, ( $r(122) = .210, p < .05$ ), and deductive reasoning subscale score, ( $r(122) = .182, p < .05$ ). No significant correlation was found between CE written simulation section scores and CCTST: total score, ( $r(122) = .145, p > .05$ ), analysis subscale score, ( $r(122) = -.025, p > .05$ ), evaluation subscale score, ( $r(122) = .071, p > .05$ ), and inductive reasoning subscale score, ( $r(122) = .072, p > .05$ ). In general, these results suggest a weak relationship between CE written simulation section scores and the critical thinking areas of inference and deductive

reasoning. There was no relationship between CE written simulation section scores and overall critical thinking skills or the areas of analysis, evaluations, or inductive reasoning.

Table 7

*Correlations Between CCTST Total and Subscale Scores and CE Section Scores*

Subscale	Written		Practical		Written Simulation	
	N	Pearson Correlation	N	Pearson Correlation	N	Pearson Correlation
Analysis	124	0.11	124	0.06	124	-0.03
Inference	124	0.39**	124	0.25**	124	0.21*
Evaluation	124	0.17	124	0.03	124	0.07
Deductive Reasoning	124	0.40**	124	0.25**	124	0.18*
Inductive Reasoning	124	0.18*	124	0.05	124	0.07
Total Score	124	0.33**	124	0.17	124	0.15

Note: \*\* Correlation is significant at .01 level (2-tailed)

\* Correlation is significant at .05 level (2-tailed)

*Summary of RQ 4.* Research question four examined the correlation between athletic training certification candidate CCTST subscale and total scores and CE section scores. Correlations were found between the inference and deductive reasoning subscales and each of the three CE section scores. Correlations were also found between the inductive reasoning subscale and total scores and the CE written section scores. The number, significance, and Pearson Correlation are presented in Table 11 categorized by CE section. The null hypothesis for research question four is rejected.

#### *Research Question 5*

Research question five examined whether or not a multiple regression model existed that predicted CE section passing scores. The summary of the model summary for each CE section is presented in three separate tables.

*RQ 5.* Is there a multiple regression model for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores?

H<sub>0</sub>5: There is no multiple regression model for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores.

*CE written section.* A multiple stepwise regression (MSR) was computed to predict a candidate's CE written section score based on their CCTST total and subscale scores. Five variables were removed, leaving only the variable of deductive reasoning in the regression equation. A significant regression equation was found for the deductive reasoning subscale ( $F(1,122) = 22.98, p < .001$ ), with an  $R^2$  of .158 and a Durbin-Watson of 1.90. Candidates' predicted CE written section score is equal to  $94.10 + (1.7 \times \text{deductive reasoning subscale score}) \pm 11.0$  (see table 8). Candidate CE written section scores increased 1.7 points for every 1 point increase in CCTST deductive reasoning subscale score. Results suggest a significant prediction model using deductive reasoning scores that does have practicality with accuracy of 15.8%. An obtained Durbin-Watson score of 1.90 indicates adjacent residuals are not correlated (Field, 2005). Athletic training educators should be aware of this finding and utilize teaching methods that improve deductive reasoning skills.

Table 8  
*Summary of Model Summary, ANOVA & Coefficients*  
*Analysis Results for CE Written Section Scores*

Source	Beta	r. sq.	SEE	F	sig.
Constant	94.10				
Deductive Reasoning	1.70	0.158	11	22.98	0.000

Note: Written section is the Dependent Variable  
 Significant at the  $<.05$  level

*CE practical section.* A MSR was computed to predict a candidate's CE practical section scores based on their CCTST total and subscale scores. A significant regression

was found for the deductive reasoning subscale, ( $F(1,122) = 8.4, p < .005$ ) with an  $R^2$  of .065 and a Durbin-Watson of 2.14. Candidates' predicted CE practical section score is equal to  $32.3 + (0.5 \times \text{deductive reasoning subscale score}) \pm 5.6$  (see table 9). CE practical section scores increased .5 point for every 1 point increase in CCTST deductive reasoning subscale score. Results suggest a significant regression model using deductive reasoning scores, but not practical with an accuracy of 6.5%. An obtained Durbin-Watson score of 2.1 indicates adjacent residuals are not correlated. Athletic training educators should be aware of this finding and consider using teaching methods that improve deductive reasoning skills.

Table 9  
*Summary of Model Summary, ANOVA, & Coefficients Analysis*  
*Results for CE Practical Section Scores*

Source	Beta	r.sq.	SEE	F	Sig.
Constant	32.3				
Deductive Reasoning	0.522	0.065	5.6	8.4	0.004

Note: Practical section is Dependent Variable  
Significant at  $< .05$  level

*CE written simulation section.* A MSR was computed to predict candidate's CE written simulation section scores based on their CCTST total and subscale scores. A significant regression was found for the CCTST inference subscale score, ( $F(1,122) = 5.60, p < .05$ ) with an  $R^2$  of .044 and a Durbin-Watson score of 1.5. Candidates' predicted CE written simulation score is equal to  $456.3 + (7.3 \times \text{inference subscale score}) \pm 96.0$  (see Table 10). CE written subscale scores increased 7.3 points for every 1 point increase in CCTST inference subscale score. Results indicate a significant regression model using the subscale score of inference, but not practical at 4.4% accuracy. The Durbin-Watson score indicates it is likely that adjacent residuals are not correlated. Athletic training

educators should be aware of this finding and consider using teaching methods that improve the critical thinking skill of inference.

Table 10

*Summary of Model Summary, ANOVA & Coefficients  
Analysis Results for CE Written Simulation Scores*

Source	Beta	r. sq.	SEE	F	Sig.
Constant	456.3				
Inference	7.33	0.044	96	5.6	0.02

Note: Written simulation section is Dependent Variable

Significant at < .05 level

*Summary of RQ 5.* Research question 5 determined if a multiple regression model exists for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores. A significant regression equation was found for each of the three sections. The CCTST deductive reasoning subscale score predicted the CE written section score. For every 1.7 points of increase in the CCTST deductive reasoning subscale score there was a 1 point increase in CE written section score. This was practical with an accuracy of 15.8%. The CCTST deductive reasoning subscale score also predicted the CE practical section score. For every .5 point increase in CCTST deductive reasoning subscale score there was a 1 point increase in CE practical section score. However, this was not practical as the accuracy was 6.5%. The CCTST inference subscale score predicted the CE written simulation section score. For every 1.7 points of increase in the CCTST inference subscale score there was a 1 point increase in CE written simulation section score. This equation was not practical as the accuracy was 4.4%. The null hypothesis for research question 5 was rejected.

### *Research Question 6*

According to Vannatta and Mertler (2001), discriminant analysis can be used to classify subjects into groups based on a combination of measures. Discriminant functions are obtained with the goal of determining dimensions that serve to reliably classify subjects into groups. In this study, discriminant analysis was used to classify athletic training candidates into groups of passing or not passing the CE and to determine what CCTST subscales best discriminated between candidates that passed and did not pass the CE.

Stevens (as quoted in Mertler and Vannatta, 2001) stated that a large sample is necessary relative to the number of variables in order for the results of discriminant analysis to be trusted. He stated that the ratio of total sample size to number of variables should be approximately 20 to 1 in order for the researcher to have confidence in interpreting the results. This study used six variables with a total sample size of 124 which computed to a 21 to 1 ratio thereby exceeding Stevens' confidence level criteria.

*RQ 6.* What CCTST subscales best discriminate between athletic training certification candidates that pass and do not pass the CE.

Ho6: There are no CCTST subscales that discriminate between athletic training certification candidates that pass and do not pass the CE.

A discriminant analysis was conducted to determine if the CCTST total score or any of the five CCTST subscales of analysis, inference, evaluation, inductive reasoning, or deductive reasoning could predict a candidate's ability to pass or not pass the CE. One significant function was generated,  $\Lambda = .818$ ,  $\chi^2(2, N=124)=24.3$ ,  $p<.001$  (see Table 11), indicating that the function of predictors significantly differentiated between candidates



that passed and did not pass the CE. Passing status was a significant function and accounted for 18.1% of the variance.

Table 11  
*Eigenvalues and Wilks' Lambda*

Function	Eigenvalue	Canonical	Wilks'	Chi-	Df	Sig.
		Correlation	Lambda	square		
1	0.222 <sup>a</sup>	0.426	0.818	24.27	2	0.000

a. First 1 canonical discriminant functions were used in the analysis

Standardized function coefficients and correlation coefficients (see table 12) revealed that the CCTST subscales of inference and inductive reasoning demonstrated the strongest relationship with passing and therefore are most associated with the function.

Table 12  
*Correlation Coefficients and Standardized Function Coefficients*

	Correlation coefficients with discriminant function	Standardized coefficients for discriminant functions
Inference	0.865	1.304
Inductive Reasoning	0.192	-0.667

An inverse relationship was found between candidate subscale scores of inference and inductive reasoning for candidates that passed and did not pass the CE. As shown in Table 13 and illustrated in Figure 1, candidates that passed the CE had a group mean of .619, while candidates that did not pass the CE had a group mean of -.353. Based on an interpretation of the discriminant function the pass group's highest mean score was on the inference subscale and their lowest mean score was on the inductive reasoning subscale; while the fail group's highest mean was on the inductive reasoning subscale and their lowest mean was on the inference subscale. These findings suggest that candidates with high inference scores and low inductive reasoning scores will most likely pass the CE. On the contrary, candidates with low inference scores and high inductive reasoning scores will likely not pass the CE.

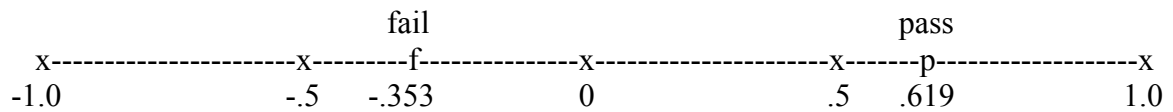
Table 13

*Functions at Group Centroids*

	Function
Pass/Fail	1
Pass	0.619
Fail	-0.353

Low Inference  
High Inductive Reasoning

High Inference  
Low Inductive Reasoning



*Figure 1.* Candidates passing the CE had a mean function of .619, scoring higher on the inference subscale and lower on the inductive reasoning subscale while candidates not passing the CE had a mean function of -.353, scoring higher on the inductive reasoning subscale and lower on the inference subscale.

Table 14 presents original candidate classification results that revealed 67% of candidates that passed the CE were correctly classified, while 73% of candidates that did not pass the CE were correctly classified. For the overall sample, 71% were correctly classified. Means of discriminant functions are consistent with these results.

Table 14

*Classification Results*

			Predicted Group Membership		
			Pass	Fail	Total
Original	Count	Pass	30	15	45
		Fail	21	58	79
	%	Pass	67	33	100
		Fail	27	73	100

a. 71% of original grouped cases correctly classified

Research question 6 determined what CCTST subscales best discriminated between athletic training certification candidates that passed and did not pass the CE. Results suggest athletic training certification candidates that scored higher on the CCTST inference subscale score while scoring lower on the inductive reasoning subscale were more likely to pass the CE. Athletic training certification candidates that scored lower on the CCTST inference subscale and higher on the inductive reasoning subscale were more likely to fail the CE. The null hypothesis for research question 6 is rejected.

### Summary

This study investigated the relationship between critical thinking skills, as measured by the California Critical Thinking Skills Test (CCTST), to candidate scores on the Certification Examination for Athletic Training (CE) administered by the National Athletic Trainers' Association Board of Certification, Inc. (BOC). The purpose of this study was to determine whether there was a relationship and predictive power of critical thinking skills scores to CE performance scores. The CCTST was used to determine if differences exist in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE.

Chapter 4 presented a review of the research design, participant selection and provided statistical analysis of data. Each of six research questions were stated along with the null hypothesis followed by tables and figures representing statistical findings as well as narrative analysis.

The research design was a non-experimental descriptive study to determine the relationship of athletic training certification candidate scores on the CCTST subscale and total scores to CE section scores. Quantitative data were collected from the CCTST and

the CE in athletic training. CCTST subscale and total scores were assigned as independent variables and CE section scores were assigned as dependent variables for analysis purposes.

## CHAPTER 5

### FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

#### *Introduction*

The Certification Examination (CE) for athletic training offered by the National Athletic Trainers' Association Board of Certification, Inc. (BOC) has proven to be a difficult challenge for athletic training certification candidates. The success rate has not been high and many have speculated as to why. One area of speculation has been that of critical thinking skills and their relationship to passing or not passing the CE. Consequently, this study examined the relationship and predictive power of athletic training certification candidates' critical thinking skills, as measured by the California Critical Thinking Skills Test (CCTST), to CE performance scores. This chapter will review the problem, purpose, null hypotheses, and design of the study. Moreover, findings, conclusions, recommendations, and a summary of the study are included in this chapter.

#### *Statement of Problem*

A high failure rate exists for first time candidates sitting for the CE. An understanding of how critical thinking skills affect the success rate for passing the CE is lacking. Although professionals understand that critical thinking skills are important, there have been no studies performed to determine the relationship between critical thinking skills and candidate scores on the CE. Therefore, it was important to investigate the relationship between critical thinking skills and scores on the CE to inform and better

prepare athletic training education program directors, faculty, and students to address the challenge of passing the CE.

### *Purpose of the Study*

The purpose of this study was determine whether there is a relationship and predictive power of critical thinking skills scores to CE performance scores. The CCTST-2000 was used to determine if differences exist in athletic training certification candidate critical thinking skills when compared to passing and not passing the CE.

### *Hypotheses for the Study*

Five null hypotheses were developed to investigate the problem and answer the research questions presented by this study.

1. The CCTST survey instrument does not have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha.
2. There is no significant difference in athletic training certification candidate CCTST subscales and total mean scores between candidates that "pass" compared to those who do "not pass" the CE ( $\alpha = < 0.05$ ).
3. There is no correlation between athletic training certification candidate CCTST subscale and total scores and CE section scores.
4. There is no multiple regression model for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores.
5. There are no CCTST subscales that discriminate between athletic training certification candidates that pass and do not pass the CE.

### *Design of the Study*

The research design was a non-experimental descriptive study to determine the relationship of athletic training certification candidate scores on the CCTST subscale and total scores for CE sections. Quantitative data were collected from the CCTST and the CE in athletic training. CCTST subscale and total scores were assigned as independent variables and CE section scores were assigned as dependent variable for analysis purposes.

#### *Participant Selection*

Participation was limited to those students enrolled in their final term prior to graduation from a CAATE accredited undergraduate athletic training education program and registered to sit for the first time for the CE and scheduled to complete all three sections in 2006 as described in Chapter 2. A total of 124 participants were obtained for inclusion the study.

A letter of inquiry was sent to 336 athletic training education program directors in the United States (See Appendix A). Program directors were asked to present the opportunity to participate in this study to their senior students. Students were offered the opportunity to volunteer to participate in a national study about critical thinking by a doctoral student who is a certified athletic trainer (see Appendix B). Per IRB requirements, all participation was strictly voluntary. Those program directors responding in an affirmative manner (61 said yes) were asked to solicit volunteers and report back the exact number of students willing to participate and have already registered to sit for the CE. The exact number of CCTST exam booklets and answer sheets were then mailed to the program director to administer the CCTST to the volunteer students. A total of 38

program directors responded with a total of 200 eligible and willing students to participate. A total of 27 program directors returned a total of 134 completed CCTST answer sheets and signed consent forms from willing students. Of the 134 students completing the CCTST, 124 actually took all three sections of the CE and were included in the study.

#### *Data analyses*

Raw score data were entered into SPSS for statistical analysis. Multiple regression analysis determined correlations. MANOVA determined discriminant analysis, independent T-test determined differences in CCTST mean scores and discriminant analysis was used to classify and predict groups into pass/fail.

The raw scores on each of the three sections of the CE were the independent variables and the subscores and total score from the CCTST were the dependent variable.

#### *Summary of Findings*

In this section the null hypotheses will be restated and summarized from the data analysis in Chapter Four. . These data analyses provided the following findings related to this study.

*Null Hypothesis 1: The CCTST survey instrument does not have internal consistency and reliability by subscale and total as measured by Cronbach's Alpha.*

It was determined that the CCTST had a high level of reliability with a high level of internal consistency. The Cronbach *Alpha* test resulted in a value of .9027 and is considered by Cronk (1999) to be highly reliable. The first null hypothesis was rejected.



*Null Hypothesis 2: There is no significant difference in athletic training certification candidate CCTST subscales and total mean scores between candidates that “pass” compared to those who do “not pass” the CE (Alpha = < 0.05).*

It was determined by independent *t* test that those candidates passing the CE had higher overall critical thinking skills and higher scores in the subscale areas of inference and deductive reasoning. If one examines the APA definition of inference, it is “to identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to educe the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation” (APA as quoted by P.A. Facione, 2004, p. 5).

This definition describes what athletic trainers do on a daily basis whenever they evaluate an athlete’s medical condition. Athletic trainers must collect data in the form of physical evaluation of the injury or illness, listen to the athlete’s complaint and history of the injury or illness, have knowledge of human anatomy, physiology, pathology, and be able to draw a conclusion based on such data. According to BOC data, the CE tests the ability of an athletic trainer to do these things, thus one may conclude that the critical thinking skill of inference would be higher in those passing the CE than those who do not pass. This null hypothesis was rejected.

*Null Hypothesis 3: There is no correlation between athletic training certification candidate CCTST subscale and total scores and CE section scores.*

It was determined by Pearson Correlation that a significant low-moderate positive correlation existed between CE written section scores and CCTST total score and

inference and deductive reasoning subscale scores. Also, a significant weak positive correlation existed between CE written section scores and CCTST inductive reasoning subscale scores.

It was determined by Pearson Correlation that a significant weak positive correlation existed between CE practical section scores and CCTST inference and deductive reasoning subscale scores.

It was determined by Pearson Correlation that a significant weak correlation existed between CE written simulation scores and CCTST inference and deductive reasoning subscale scores.

*Null Hypothesis 4: There is no multiple regression model for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores.*

It was determined by multiple stepwise regression that CE written section scores increased 1.7 points for every 1 point of increase in CCTST deductive reasoning subscale score.

It was determined by multiple stepwise regression that CE practical section scores increased .5 point for every 1 point of increase in CCTST deductive reasoning subscale score.

It was determined by multiple stepwise regression that CE written simulation section scores increased 7.3 points for every 1 point of increase in CCTST inference subscale score.

*Null Hypothesis 5: There are no CCTST subscales that discriminate between athletic training certification candidates that pass and do not pass the CE.*

It was determined by discriminant analysis that a prediction model existed. Athletic training certification candidates that scored higher on the CCTST inference subscale and lower on the inductive reasoning subscale could be predicted to have a better chance of passing the CE. Athletic training certification candidates that scored low on the inference subscale and higher on the inductive reasoning subscale could be predicted to have a better chance of failing the CE.

### *Discussion of Findings*

This section will provide a discussion of the findings of the study. Findings are presented as they relate to each research question.

#### *Research Question 1*

The CCTST-2000 is a reliable test for critical thinking skills with a satisfactory level of internal consistency.

#### *Research Question 2*

The descriptive statistics provided an overall view of the means, standard deviation, and N of the study. Histograms found in Appendix D provided a visual look at the bell curves for each CCTST subscale and total score as well as scores on each of the three CE sections. It can be said that the frequencies are well balanced although some are slightly skewed.

#### *Research Question 3*

Several findings resulted from research question three. They are:

1. There is a significant difference in the means of athletic training certification candidate CCTST subscale scores of inference and deductive reasoning and total score between candidates that pass and do not pass the CE. Athletic

training educators should be aware of this fact and structure curriculum to meet the goal of improving student skills of inference and deductive reasoning. Both inference and deductive reasoning require the use of various truths before reaching a conclusion. Deductive reasoning requires the use of strict rules and laws. Given a set of facts or data, if we assume all are true, we believe our conclusion cannot be false. Inference skills require us to draw our conclusions based on reasons and evidence (Insight Assessment, 2007). Since athletic trainers must reach a conclusion regarding an injury, sometimes referred to as diagnosing a problem, it is necessary to base the diagnosis on true facts, reasons, and evidence.

2. There is a significant difference in the means of athletic training certification candidate CCTST subscale scores of inference, inductive reasoning, and deductive reasoning and total score between candidates that pass and do not pass the CE written section. Since the CCTST total score is a sum of the subscales of analysis, inference and evaluation, or the sum of inductive and deductive reasoning, it makes mathematical sense that the means of the total score show a significant difference between athletic training certification candidates that passed and did not pass the written section of the CE if there is a significant difference in the means of inductive and deductive reasoning between the same two groups. It is interesting to note that this is the only section in which inductive reasoning had any significant contribution to success in passing.

3. There is a significant difference in the means of athletic training certification candidate CCTST subscale scores of inference and deductive reasoning and total score between candidates that pass and do not pass the CE practical section.
4. There is a significant difference in the means of athletic training certification candidate CCTST subscale scores of inference and deductive reasoning and total score between candidates that pass and do not pass the written simulation section of the CE.
5. A trend is discovered by examining the results of the difference in the means of athletic training certification candidate CCTST subscale scores between candidates that passed and did not pass the CE. The subscales of inference and deductive reasoning provide a difference between candidates that passed and did not pass each section of the CE. With this trend, athletic training educators should be keenly aware of developing these skills in athletic training students.

#### *Research Question Four*

Research question four examined the correlation between athletic training certification candidate CCTST subscale and total scores and CE section scores.

Correlations were found between the inference and deductive reasoning subscales and each of the three CE section scores. Correlations were also found between the inductive reasoning subscale and total scores and the CE written section scores. Therefore, it is suggested that athletic training education programs provide some method of increasing student critical thinking skills, especially in the areas of inference and deductive reasoning. Considering the clinical judgment required of athletic trainers, this finding

supports Bowles (2000) finding that demonstrated a positive correlation of the subscales of inference but not her finding of a positive correlation of inductive reasoning to clinical judgment in nursing.

#### *Research Question Five*

Research question 5 determined a multiple regression model exists for athletic training certification candidate CCTST subscale and total scores that predicts CE section passing scores. A significant regression equation was found for each of the three sections. The CCTST deductive reasoning subscale score predicted the CE written section score. For every 1.7 points of increase in the CCTST deductive reasoning subscale score there was a 1 point increase in CE written section score. This was practical with an accuracy of 15.8%. The CCTST deductive reasoning subscale score also predicted the CE practical section score. For every .5 point increase in CCTST deductive reasoning subscale score there was a 1 point increase in CE practical section score. However, this was not practical as the accuracy was 6.5%. The CCTST inference subscale score predicted the CE written simulation section score. For every 1.7 points of increase in the CCTST inference subscale score there was a 1 point increase in CE written simulation section score. This equation was not practical as the accuracy was 4.4%. Again, deductive reasoning and inference prove to be critical thinking skills that improve an athletic training certification candidate's ability to pass each section of the CE.

#### *Research Question Six*

Research question 6 determined what CCTST subscales best discriminated between athletic training certification candidates that passed and did not pass the CE. Results suggest athletic training certification candidates that scored higher on the CCTST

inference subscale score while scoring lower on the inductive reasoning subscale were more likely to pass the CE. Athletic training certification candidates that scored lower on the CCTST inference subscale and higher on the inductive reasoning subscale were more likely to fail the CE. Again, the critical thinking skill of inference provides the athletic training certification candidate with an improved opportunity to pass the CE. Examining the results further, if a candidate scores higher on the subscale of inductive reasoning, he or she will score lower on the CE. One may conclude that if inductive reasoning causes lower scores on the CE, it may be possible to score higher by using deductive reasoning skills in place of inductive reasoning skills. Therefore, it may be suggested that athletic training education programs emphasize deductive reasoning skills over inductive reasoning skills.

### *Conclusions*

New knowledge derived from the findings and rejection of the Null Hypotheses provided the foundation for the following conclusions:

1. Strong critical thinking skills provide a greater probability of passing the CE.
2. Athletic training certification candidates with strong critical thinking skills of inference and deductive reasoning are more likely to pass each section of the CE and the entire test.
3. Athletic training certification candidates can score higher on the CE written and practical sections by improving deductive reasoning skills.
4. Athletic training certification candidates who rely on strong inductive reasoning skills have a greater probability of not passing the CE.

### *Recommendations*

This section will provide recommendations for educators and students based on the results of the study. Recommendations for future research will also be presented.

#### *Recommendations for Educators and Students*

Critical thinking skills have been shown to improve performance on the CE. Based on this new information from the findings and conclusions of this study are the following recommendations for athletic training educators and students.

1. Athletic training education programs should examine the methods used to teach athletic training students.
2. Athletic training educators should know how to teach students the skills of critical thinking as they pertain to the profession of athletic training. Special attention should be made to the development of the skills of inference and deductive reasoning. Development of critical thinking skills will enhance the ability of athletic training certification candidates to pass the CE.
3. Athletic training students should know their personal critical thinking skills and attempt to improve in areas that are weak.

#### *Recommendations for Future Study*

The purpose of this study was to determine whether there is a relationship and predictive power of critical thinking skills scores to CE performance scores. The recommendations for future study that follow are based on the findings and conclusions of the study.



1. Future studies should provide for more control over the administration of the CCTST. This should provide investigators with more consistency of results on the CCTST.
2. Further study should be done regarding the development of critical thinking skills for athletic training students. The review of literature pointed out various methods of developing critical thinking skills. Discovering methods of improving critical thinking skills of athletic training students would allow for specific curricular changes in athletic training education programs.
3. Involving participants that have previously not passed one or more of the three sections of the CE would strengthen the study.
4. Future studies should investigate longitudinal data. This would allow researchers to track students from entry into the educational program to graduation and investigate changes in critical thinking skills.
5. Future studies should investigate longitudinal data of the certified athletic trainer. This would allow researchers to track professionals from entry into the profession to various time frames of career and investigate changes in critical thinking skills as they relate to experience and age.

#### *Summary of the Study*

Using Cronbach's Alpha, it was determined that the CCTST had a high level of reliability with a high level of internal consistency. It was determined by independent *t* test that those candidates passing the CE had higher overall critical thinking skills and higher

scores in the subscale areas of inference and deductive reasoning. It was determined by Pearson Correlation that a correlation existed between CE written section scores and CCTST total score and inference, deductive reasoning, and inductive reasoning subscale scores. It was also determined by Pearson Correlation that a correlation existed between CE practical section scores and CCTST inference and deductive reasoning subscale scores as well as CE written simulation scores and CCTST inference and deductive reasoning subscale scores. It was determined by multiple stepwise regression that CE written section scores increased 1.7 points for every 1 point of increase in CCTST deductive reasoning subscale score, that CE practical section scores increased .5 point for every 1 point of increase in CCTST deductive reasoning subscale score, and that CE written simulation section scores increased 7.3 points for every 1 point of increase in CCTST inference subscale score. It was determined by discriminant analysis that a prediction model existed. Athletic training certification candidates that scored higher on the CCTST inference subscale and lower on the inductive reasoning subscale could be predicted to have a better chance of passing the CE. Athletic training certification candidates that scored low on the inference subscale and higher on the inductive reasoning subscale could be predicted to have a better chance of failing the CE.

In summary, athletic training educators should know how to improve the critical thinking skills of students enrolled in athletic training education programs. Athletic training educators should consider the use of methods to improve the critical thinking skills of athletic training students. Likewise, athletic training education students should know their personal critical thinking abilities and strive to improve in areas that are weak.

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## Appendix A

Date

Vince Stilger, PhD  
Athletic Training Program Director  
Coliseum  
West Virginia University  
Morgantown, WV 26506

Dear Dr. Stilger,

I am currently working on a doctoral dissertation entitled, "The correlation of critical thinking skills and scores on the NATABOC certification examination for athletic training". A large portion of the study is to gather critical thinking skills scores for senior athletic training students. I need the voluntary participation of students in their last semester of their athletic training education program who will be sitting for all three sections of NATABOC exam during the 2006 calendar year.

I am asking for your cooperation in gathering the data described above. In doing so, I would ask your students to take a critical thinking skills test sometime this spring semester. I would ask you to administer the test at a convenient time for you. The test is a timed test lasting 45 minutes. I would ask each student to use their NATABOC candidate ID number as the identification number on the inventory answer sheet. Following administration of all inventories, you will return all tests and answer sheets to me via a postage paid envelope I will provide. I will also request your students give permission to the NATABOC to send their exam scores to me, identified only by their candidate ID number.

I will never be able to identify any individual student. I will only be able to match their critical thinking scores to their NATABOC exam score using the candidate ID number.

I would be most happy to send the results of the study to you if you so desire. Please indicate your desires and I will accommodate you.

Thank you for your consideration of this request. If you agree to participate, I will be in contact with you very soon and send you the appropriate number of critical thinking skills inventories for your administration to your students. Please complete the enclosed response sheet as soon as possible. You may return it via mail in the enclosed self-addressed, stamped envelope or via fax to 660-562-1985.

Sincerely,

David E. Colt, MSED, ATC, LAT

University of Missouri, doctoral candidate

**PLEASE COMPLETE THE INFORMATION BELOW AND  
RETURN TO ME USING THE ENCLOSED SELF-  
ADDRESSED STAMPED ENVELOPE OR VIA FAX TO  
660-562-1985**

**NAME:**\_\_\_\_\_

**SCHOOL:**\_\_\_\_\_

**TITLE:**\_\_\_\_\_

**ADDRESS:**\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**PHONE:**\_\_\_\_\_

**EMAIL:**\_\_\_\_\_

\_\_\_\_\_**YES, I AM WILLING TO PARTICIPATE. PLEASE  
CONTACT ME WITH FURTHER INFORMATION.**

\_\_\_\_\_**NO, I WILL NOT BE ABLE TO PARTICIPATE**

## Appendix B

Date \_\_\_\_\_

Thank you for considering participating in my study of the relationship and predictive power of critical thinking skills scores to NATABOC Certification Examination for Athletic Training performance scores. This study is being conducted as part of my dissertation in my doctoral program, and will be published and disseminated to a wider audience.

Before you make a final decision about participation, I need to explain how your participation will be used in the study and how your rights as a participant will be protected.

- **Participation in this study is completely voluntary.** You may withdraw from participation at any time you wish, including the middle of the testing procedure. Please do not hesitate to contact me with any concerns or questions about your participation. You may reach me at 660-562-1313. You may also reach my dissertation committee chair, Phillip Messner, EdD, Professor of Educational Leadership in the College of Education at Northwest Missouri State University and Lead Instructor in the University of Missouri at Columbia statewide cooperative doctoral program at 660-562-1478. His email is: [pemday@nwmissouri.edu](mailto:pemday@nwmissouri.edu). My email address is: [dc@nwmissouri.edu](mailto:dc@nwmissouri.edu).
- **Your identity will be protected in this study.** The only identification used in this study will be your NATABOC Candidate ID Number. I will not have access to names that match this number. I will ask you to use this number when completing the answer sheet and any other communication with me. The only place your name will appear will be as a signature on this participation letter. I will not be able to match your name with your candidate ID number.
- You will be asked to participate by taking the California Critical Thinking Skills Test (CCTST-2000), published by Insight Assessment/The California Academic Press. The CCTST will provide a score based on your personal critical thinking skills. The CCTST Total Score targets the strength or weakness of one's skill in making reflective, reasoned judgments about what to believe or what to do. The CCTST generates several scores relating to critical thinking. The CCTST is in a 34 item multiple choice format and is timed to take no more than 45 minutes to complete. You will use your NATABOC Candidate ID Number on the answer sheet.
- You are requested to release your scores on the NATABOC Certification Examination for Athletic Training after you complete all three sections. The NATABOC will provide your scores to me matched to your candidate ID number only. Your name will never appear on any communication from the BOC. You will find enclosed in this communication a release form to be signed and sealed inside a self-addressed stamped envelope. DO NOT put your candidate ID number on this letter.

- Per NATABOC regulations, confidentiality is of utmost importance. The exam scores are confidential and will not be disclosed unless the BOC receives a written request to do so from a candidate or is directed to do so by subpoena or court order. A candidate wanting scores released to another entity must indicate in writing which particular scores may be disclosed and identify specifically the person or organization to which the scores should be revealed. No candidate scores will be given by telephone, facsimile, or electronic means for any reason.
- I will compare your scores on the CCTST-2000 with your scores on the NATABOC Certification Examination to determine if there is a correlation between critical thinking skills and certification exam scores.

If at this point you are still interested in participating, please complete the enclosed consent form. Keep this letter as well as a copy of the consent form for future reference. Thank you for your time and consideration.

Sincerely,

David Colt, ATC, LAT  
Doctoral Candidate

I \_\_\_\_\_, agree to participate in the study of the relationship and predictive power of critical thinking skills scores to NATABOC Certification Examination for Athletic Training performance being conducted by David E. Colt, ATC, LAT. I understand that:

My participation is completely voluntary, and I may withdraw at any point in the study.  
My identity will be protected in reporting of all scores as well as the findings.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_

## Appendix C

### PERMISSION TO RELEASE NATABOC CERTIFICATION EXAMINATION SCORES

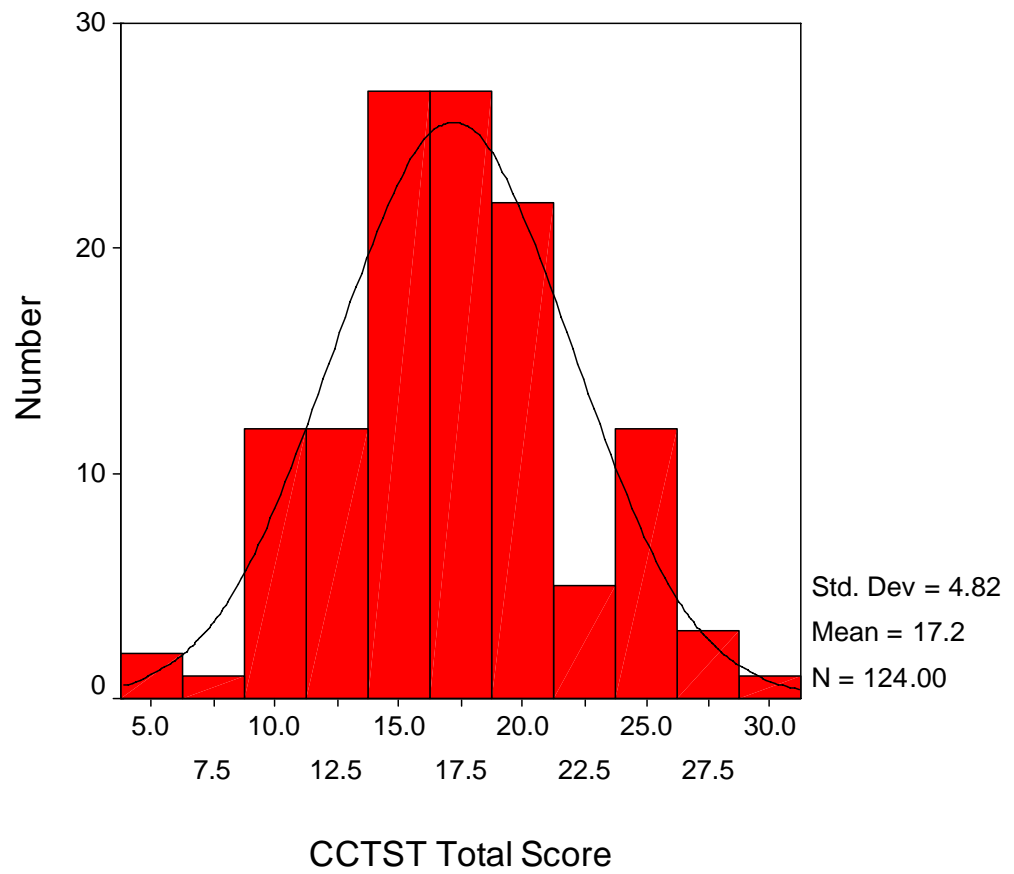
Per the following statement found on the NATABOC web site:

4. Confidentiality
  - a. The exam scores are confidential and will not be disclosed unless the BOC receives a written request to do so from a candidate or is directed to do so by subpoena or court order. A candidate wanting scores released to another entity must indicate in writing which particular scores may be disclosed and identify specifically the person or organization to which the scores should be revealed. No candidate scores will be given by telephone, facsimile, or electronic means for any reason.

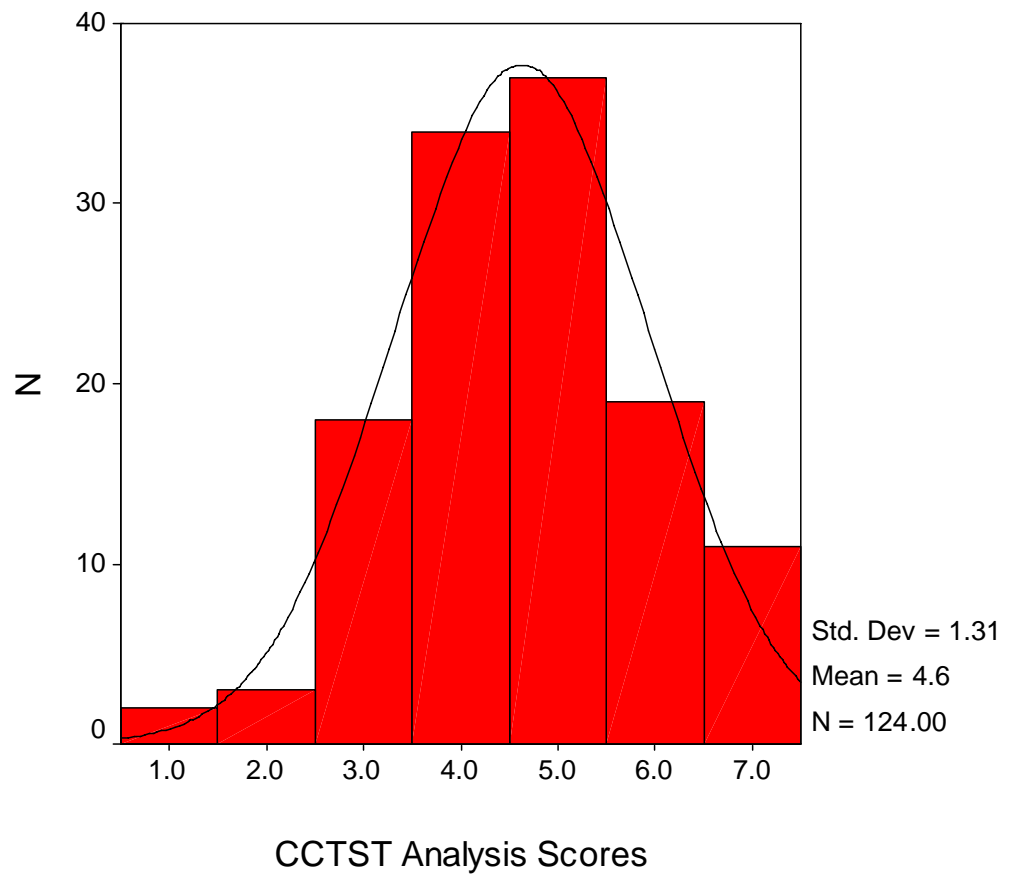
I \_\_\_\_\_ hereby give permission to NATABOC, Inc to release my scores for all three sections of the NATABOC Certification Examination for Athletic Training to David E. Colt, ATC, LAT, a doctoral candidate at the University of Missouri and a faculty member at Northwest Missouri State University. I ask my scores be released using ONLY my Candidate ID number identifying my scores.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_

## Appendix D

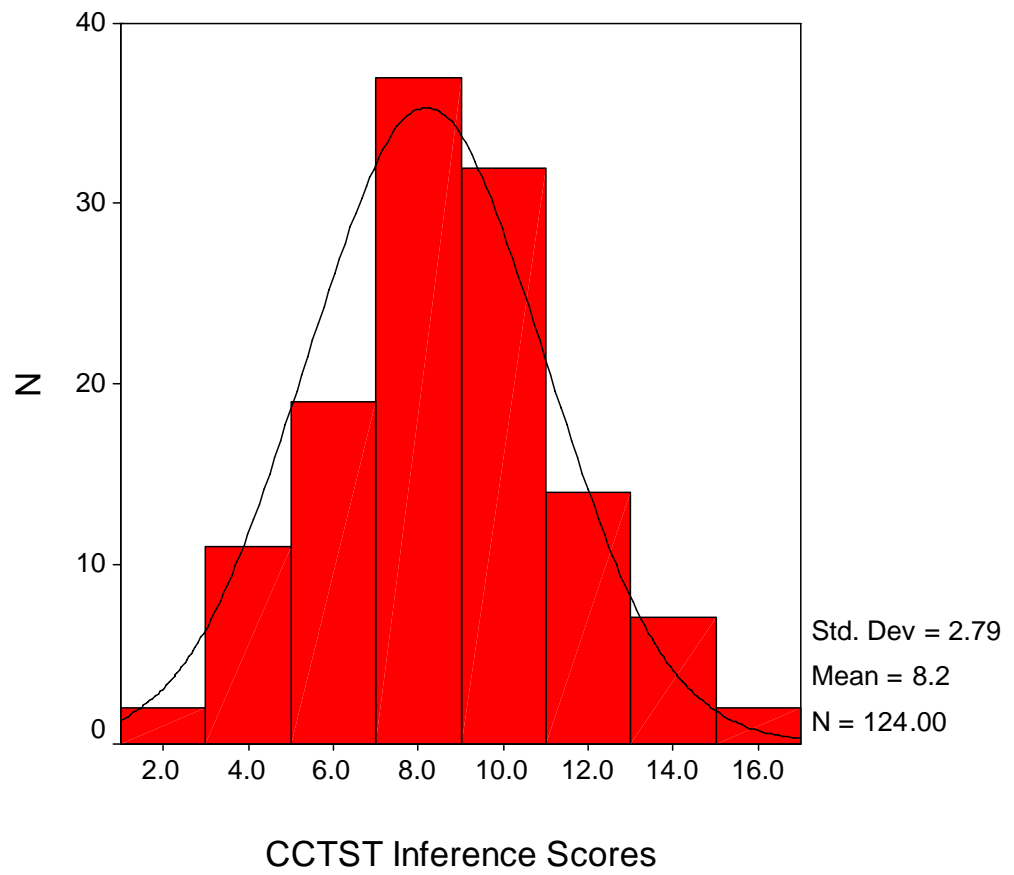


*Figure 1.* Histogram showing frequency of CCTST total scores are well balanced except for a fewer number of scores at 22.5.

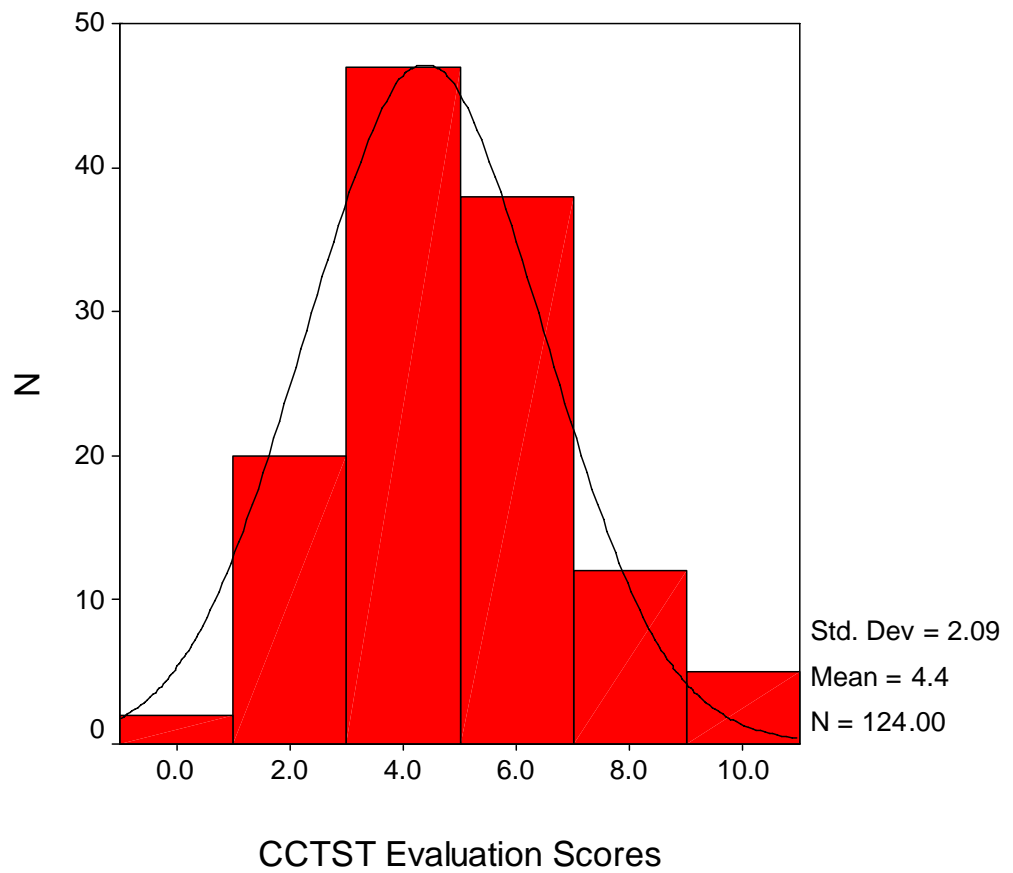


*Figure 2.* Histogram showing CCTST Analysis Scores balanced but slightly skewed toward higher scores.



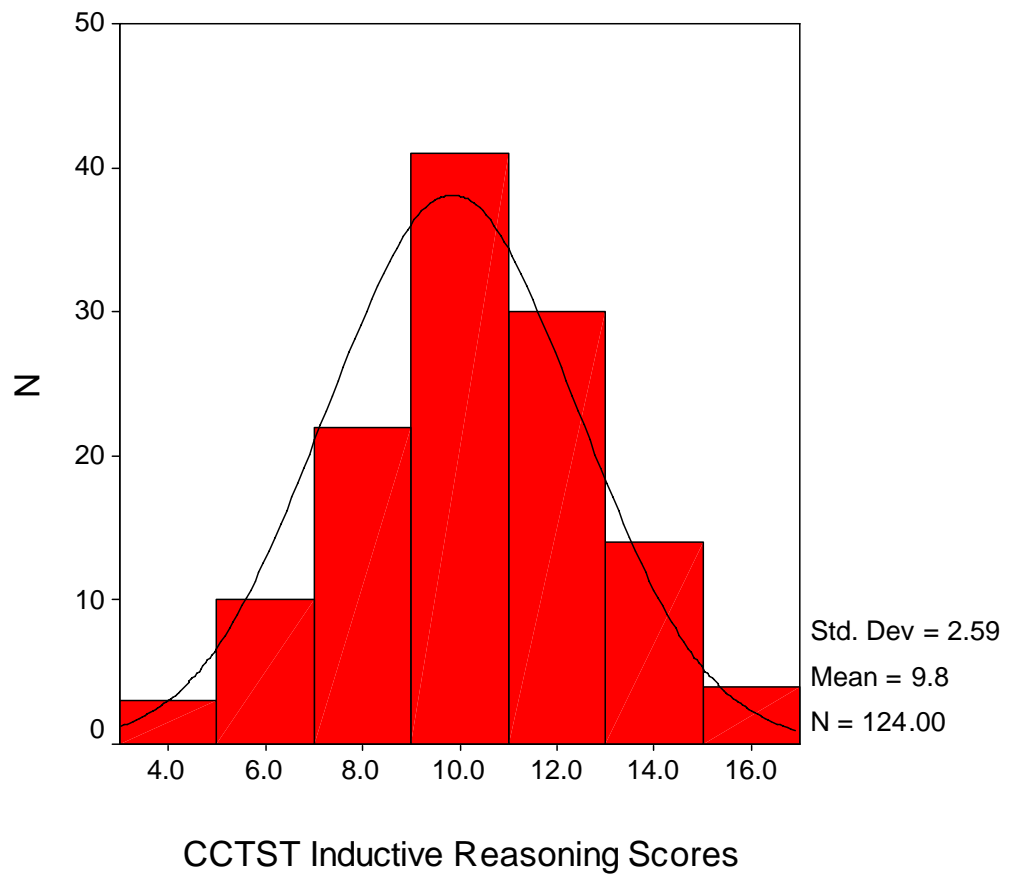


*Figure 3.* Histogram showing CCTST Inference Scores with the bell curve well balanced.



*Figure 4.* Histogram showing CCTST Evaluation Scores very slightly skewed toward the lower end of scoring.

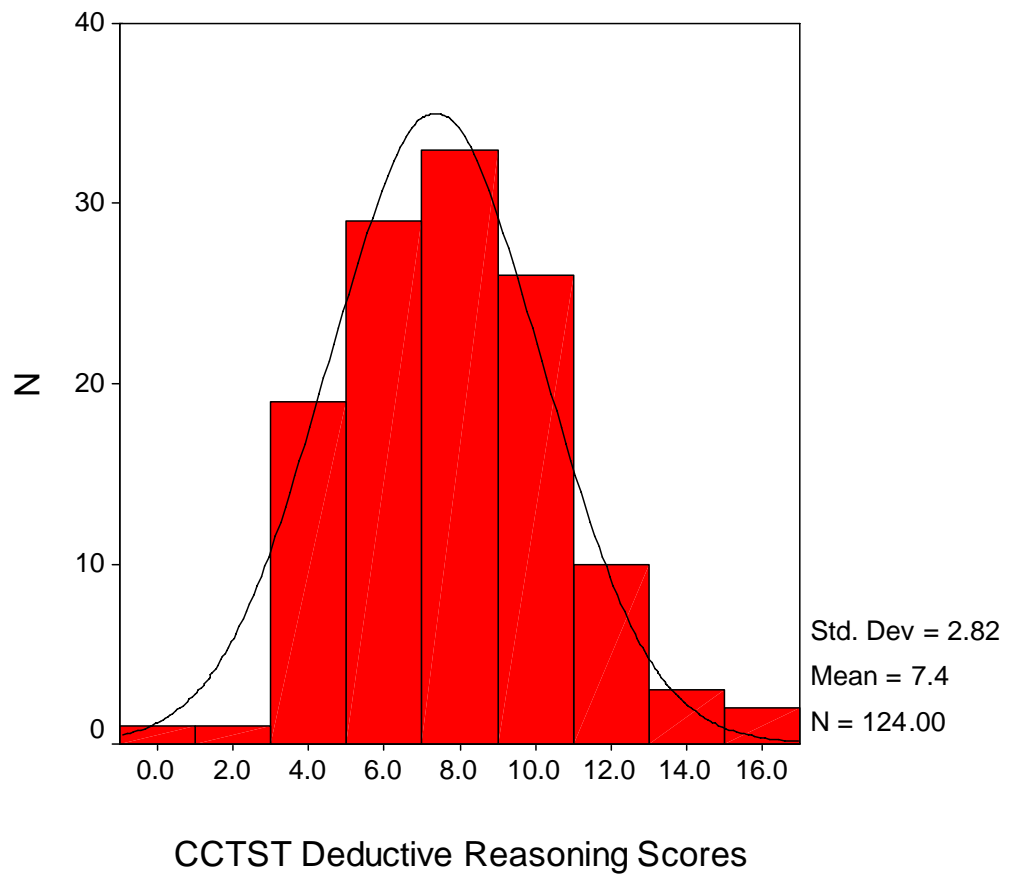
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*Figure 5.* Histogram showing CCTST Inductive Reasoning Scores very slightly skewed toward

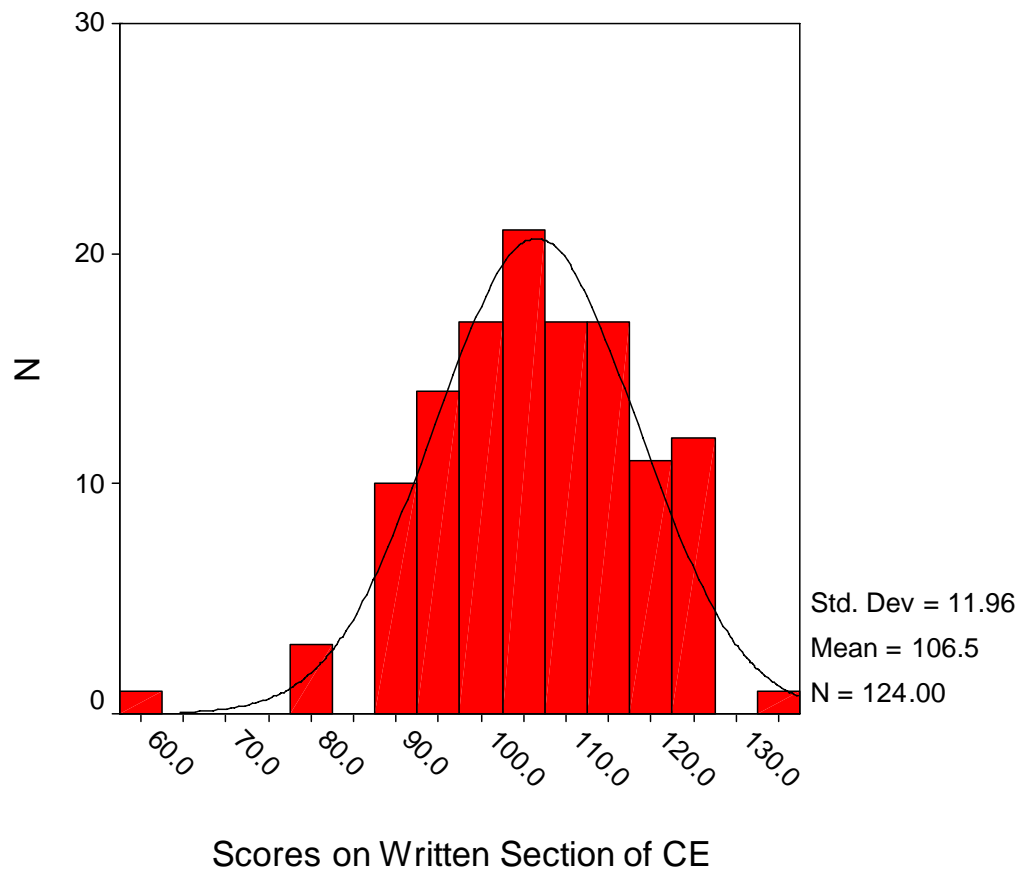
The higher end of scoring.

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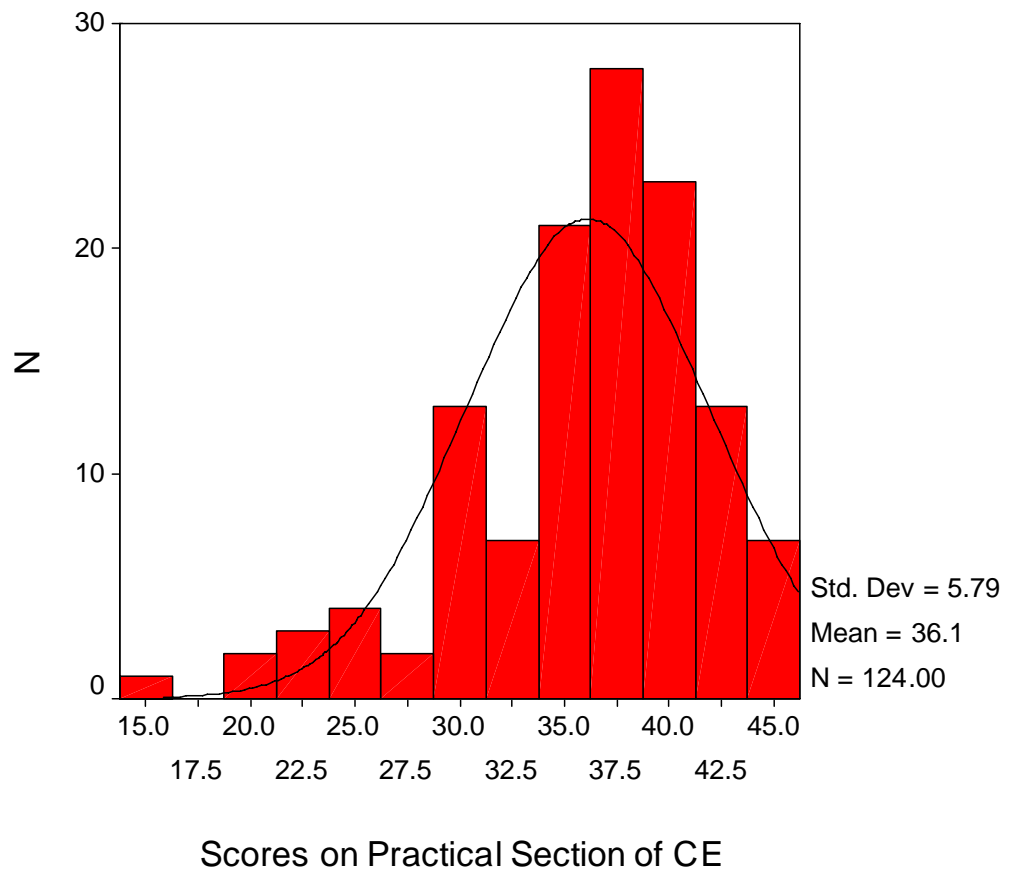
*Figure 6.* Histogram showing CCTST Deductive Reasoning Scores very slightly skewed toward the low end of scoring.

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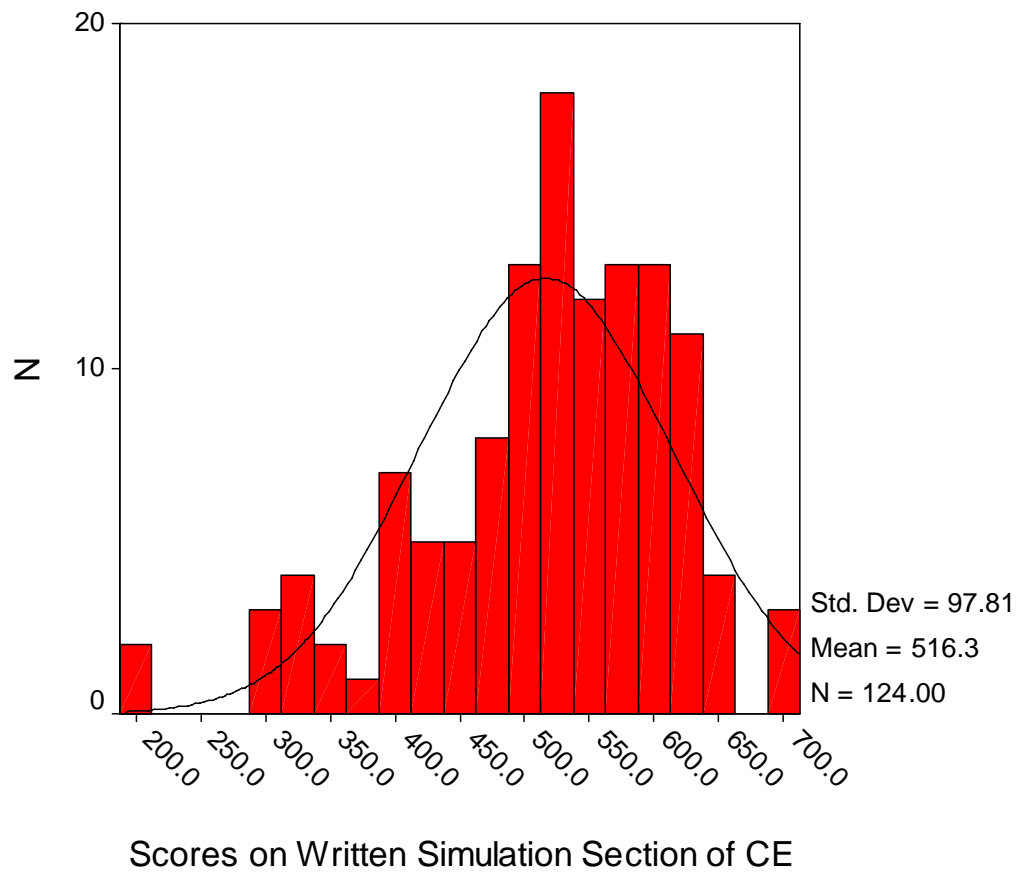
*Figure 7.* Histogram showing performance scores of athletic training certification candidates on the Written Section of the CE with one very low score skewing the curve.

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*Figure 8.* Histogram showing performance scores of athletic training certification candidates on

Practical Section of the CE skewed toward the higher end of scoring with a slow rise due to a few low scores.



*Figure 9.* Histogram showing performance scores of athletic training certification candidates on written simulation section of the CE skewed toward the higher end of scoring.

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## VITA

David E. Colt was born in Buffalo, New York on November 23, 1954. Following graduation from Kenmore West Senior High School in 1972, he completed the Degree of Bachelor of Science in Physical Education at West Virginia University (1977) and the Degree of Master of Science in Education (1978). He is a doctoral candidate for the Education Doctorate Degree in Educational Leadership and Policy Analysis, University of Missouri – Columbia.

His professional experience includes three years as Assistant Athletic Trainer at Temple University in Philadelphia, PA. Currently he is in his 27<sup>th</sup> year at Northwest Missouri State University as the Head Athletic Trainer in the Department of Athletics. He is also an Assistant Professor of Health, Physical Education, Recreation, and Dance.