

Critical Thinking Skills as Related to University Students' Gender and Academic Discipline

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Abstract

The purpose of this study was to determine if there were differences in the 5 dimensions of critical thinking based on colleges and gender based upon 1,455 graduating seniors for the 2009-2010 academic year on the (CCTST). This study used descriptive and inferential statistics to analyze data. In this quantitative study, data from the (CCTST) were gathered and distributed to the researcher for compilation and statistical analysis. Findings from this study indicate that gender and major college of study significantly influence the means on the dimensions of the CCTST. This study provides information regarding critical thinking skills in a higher education setting and is useful for higher education practitioners in facilitating the development of critical thinking skills. The results of this study add to the body of knowledge regarding critical thinking.

Key Words: California Critical Thinking Skills Test, Constructivism, Critical Thinking, Gender

1. INTRODUCTION

Because of a shift in focus from critical thinking to standards-based assessment in American education, this study analyzed the data from The California Critical Thinking Skills Test (CCTST) administered to seniors at a university in the southeastern section of the United States. The instrument used in this study delineates five dimensions of critical thinking. This study provides information regarding the need to develop critical thinking skills in an educational environment that emphasizes "one size fits all" standardized testing. The purpose of this study was to investigate the relationship of the five dimensions of critical thinking as measured by the CCTST as related to gender and academic discipline within a university setting.

Through quantitative analysis of the CCTST administered to graduating seniors at the selected university, this study investigated the relationship of gender among the five dimensions of the instrument. The following research question was addressed:

Is there a significant difference in mean scores for male and female students and the six major academic colleges on the five dimensions of the CCTST that include analysis, deduction, evaluation, induction, and inference?

2. RELATED LITERATURE

The educational system in the United States has experienced a major shift within the last 30 years. This shift reflected a change from the intent of the early progressivists who focused on critical thinking to an essentialist approach that focused on core-content memorization and recitation (Sadker & Sadker, 2003). Present legislation including but not limited to the No Child Left Behind Act of 2001 demands the accountability of public school systems, typically measured by outcome-based assessments in the form of standardized testing.

The philosophy of progressivism as espoused by John Dewey promoted the practice of critical thinking through a reflective experience enhanced by teacher-pupil discussion (Slavin, 2009). The philosophy of essentialism, prevalent in American education, is evident by the demand to follow set curricula focused on specific and measurable academic standards.

Although the teaching of critical thinking skills was determined to be a goal for American education by The National Educational Goals 2000, the push to promote standardized testing with a consequent move from progressivism to essentialism has moved the focus on critical thinking from a national priority to an objective of much lesser importance (Sadker & Sadker, 2003). The report, *A Nation at Risk*, (National Commission on Excellence in Education, 1983) initiated educational reform that emphasized accountability through standardized testing. This reform has led school educators and schools to be evaluated on the test score gains demonstrated by measuring content knowledge; consequently the teaching of critical thinking skills has become a low priority. The balance of *testing* what a student knows and *determining* what a student knows is a complex process. The emphasis on obtaining high scores from standardized testing impedes this balance (Marzano, 2007), and funding for public education is directly related to gains from standardized test scores. Although gains in test scores may be important information regarding the effectiveness of a learning environment, students must learn critical thinking skills in order to view the world accurately, to become lifelong learners and competent problem solvers, and to contribute to a highly skilled workforce capable of competing within the global market (Trottier, 2009).

The relationship between content and critical thinking presents a unique challenge in American education. Instructional requirements emphasizing the mastery of academic standards of learning mandated by the No Child Left Behind Act make it difficult if not impossible to focus instruction on teaching critical thinking skills. Federal and state funding as well as the rehiring of instructors is tied to the successful mastery of academic requirements addressed in the legislation. Matheny (2009) stated that public school educators become so overly focused on students passing specific academic standards that many teach to the test itself. Matheny (2009) discussed the debate between educators and government by addressing the emphasis of critical thinking in the classroom. Matheny suggested there is a fear from educators that an overemphasis of critical thinking skills will affect core content memorization. According to Willingham (2009), however, the development of critical thinking skills improves content memorization and retrieval. Critical thinking skills must be carefully examined to determine the effect on core content knowledge. It must be determined if critical thinking is a helpful tool and if it is appropriate in most settings. Matheny (2009) proposed that critical thinking skills and core content acquisition support each other and the idea of choosing between the two is a false dichotomy. Matheny further emphasized that instruction in critical thinking and core content are designed to be delivered simultaneously.

Critical thinking is a skill that should be taught early, practiced often, and should not be pushed from core content designs (Trottier, 2009). Students appear to be better critics than critical thinkers from evidence that looks at student reactions to skepticism and developing personal points of view. The acquisition of content typically requires choosing whether a concept is true and then applying that truth to a given situation. Critical thinking goes beyond and requires evaluating, questioning, and synthesizing new information. Knodt (2009) stated that students have a natural curiosity to explore content beyond a lower level of rote knowledge to a more complex higher-level of thinking that analyzes and evaluates. Knodt (2009) stated that innovative thinking is enhanced when the natural inquisitiveness students bring to the learning process is inspired, affirmed, and cultivated. When given the opportunity to ask and explore openly, students learn and thrive. This opportunity must be provided by the educator if students are to learn to be critical thinkers rather than critics.

Opportunities must be provided for students to voice opinions and objections to topics rather than seek right or wrong answers. This brainstorming process is necessary to fuel the continuing curiosity of the learner. Content knowledge is best taught using natural curiosity because there is an innate desire within everyone to learn by challenging thinking (Healy, 1990). Critical thinking, higher order thinking, and problem solving make learning motivating, energizing, and fun (Jensen, 2005). When critical thinking skills are omitted from the educational process, society misses tremendous benefits (Jenkins, 2009). Jenkins shared that students who lack critical thinking skills and teachers who do not teach them inhibit students' ability to think. He stated that the cognitive demands that come from being challenged to think in new and unfamiliar ways are invaluable to intellectual development. Tsui (2002) shared that critical thinking skills challenge what is typically assumed by others and encourages students to recognize the importance of different perspectives in problem solving.

3. RESEARCH METHODOLOGY

This study was designed to use descriptive and inferential statistics to analyze data collected. A quantitative research design was followed to find the association between the dependent and independent variables.

In choosing a quantitative research design, the researcher chose to compare the mean scores of groups to determine the interaction between variables of a university students' gender and academic discipline within the five dimensions of the CCTST. The population for this study is 1,455 graduating seniors for the school year 2009-2010 at a university with an enrollment of approximately 15,000 located in the southeastern United States. The primary service area includes students from 15 primarily rural counties in northeast Tennessee, southwest Virginia, and western North Carolina. The majority of students are residents of the 3 counties surrounding the university. Last semester seniors are required to take the California Test of Critical Thinking Skills. The survey instrument used in this study for data collection was the California Critical Thinking Skills Test developed in 1990 by Peter Facione and published by California Academic Press. Although it is important to assess critical thinking to drive educational improvement efforts, obstacles to assessment are present and include what should be measured and what tools should be used for the assessment. One of the premier instruments to evaluate critical thinking is the California Critical Thinking Skills Test.

The purpose of the application of the California Critical Thinking Skills is to determine if individuals have received appropriate instruction and practice in developing critical thinking skills. Additionally, it is useful to determine if students are adequately equipped to apply these skills in the world beyond their college experiences. Many states require state and federally funded colleges and universities to test graduating seniors with a standardized exam of general education. Results from the CCTST not only measure critical thinking but also the effectiveness of general education in its entirety. The California Critical Thinking Skills Test, as used at the undergraduate level, consists of 34 multiple choice items that vary in difficulty and complexity. The CCTST is specifically designed so that researchers can use the results with the purpose of evaluating program applicants, developing curriculum, and obtaining standardized data for evaluation, research, and accreditation. The results of each test returns 5 different scores based on different scales including analysis, inference, evaluation, inductive reasoning, and deductive reasoning. There is also a composite result of these totals that results in a critical thinking skills composite test score (California Academic Press, 2006).

The California Critical Thinking Skills Test is used in numerous educational settings worldwide. One particular study by Facione and Facione (2010) looked at the correlations between the test and undergraduate student-related factors regarded as indicators of academic ability and success. The study investigated whether the California Critical Thinking Skills Test efficiently measured improvement in critical thinking or not. Data were gathered on more than 1,000 undergraduate students of California State University, involving some students who were enrolled in courses specifically designed to enhance critical thinking abilities. The investigators were careful to examine instructor-related factors in order to look at extrinsic factors. Testing models looking at the deterioration of skills were developed for predicting opposing results for the test. After repeated comparisons, researchers determined that critical thinking skills could be predicted by a combination of individual verbal Scholastic Aptitude Test—or SAT—score; the mathematics SAT score, and the cumulative GPA, or grade point average. The aptitude test's results were correlated positively with reading test scores for vocabulary, comprehension, and the total score. The only factor that students encountered during the undergraduate experience that significantly affected any score on the test involved the number of years of teaching experience student's instructors possessed and how recently the students received critical thinking skills instruction. Furthermore, these studies revealed no evidence that indicated improvement in students' critical thinking skills is a result of undergraduate education but a result of educational courses that targeted critical thinking skills (Facione & Facione, 2010).

Each subtest of the CCTST is similar in structure. The subtests present test-takers with different types of questions with the goal of analyzing or interpreting information presented in texts, charts, or images; drawing accurate and warranted inferences; assessing inferences and explaining why they indicate strong or weak reasoning; and explaining why a given evaluation of an inference is either strong or weak (Facione & Facione, 2010) The CCTST measures how effective college classes have been in teaching critical thinking skills. The CCTST focuses primarily on evaluating core critical thinking skills of analysis-interpretation, inference, and evaluation-explanation. Questions from the test require students to draw inferences, make interpretations, analyze information, identify claims and reasons, and evaluate the quality of arguments. Ten versions of the CCTST are available, ranging from formats relevant to public education to those appropriate for graduate students. While the tests are different in terms of complexity, all provide objective assessment of critical thinking skills. Analysis, evaluation, and inference are particularly denoted on the CCTST as well as the elements of deductive reasoning and inductive reasoning.

On the CCTST analysis is the ability to pull apart arguments and points of view to show why people think the way they do. It is the means to comprehend and express the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria (Facione & Facione, 2010). This includes the skills of categorization, decoding, significance, and clarifying meaning. In addition analysis from the CCTST includes identifying the intended and actual inferential relationships among statements, questions, concepts, descriptions, or other forms of representation intended to express beliefs, judgments, experiences, reasons, information or opinions Included in this category is examination of ideas, detecting arguments, and analyzing the elements of argument.

On the CCTST evaluation is the ability to decide how strong or weak an argument may be. It is the means to assess the credibility of statements or other representations that are accounts or descriptions of a person's perception, experience, situation, judgment, belief, or opinion. It is also designed to assess the strength of relationships among statements, descriptions, questions, or other forms of representations (Facione & Facione, 2010). Associated with the evaluation dimension are the skills of being able to assess claims and assess arguments. Evaluation as interpreted by the CCTST means to state the results of reasoning; to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which results were based and to present reasoning in the form of cogent arguments. This includes the skills of stating results, justifying procedures, and presenting arguments.

The CCTST uses inference as a means to identify elements needed to draw reasonable conclusions based on reasons and evidence to form hypotheses, to consider relevant information, and to deduce the consequences from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation (Facione & Facione, 2010). Also included are the sub-skills of querying evidence, drawing conclusions, and discovering alternatives. Deductive reasoning skills are tested by determining whether a conclusion is true or not. Deductive reasoning is the ability to determine if a conclusion is true if the premises leading to it are true. Clues are given in a particular situation and the test taker must look at the sequence of events, relationship between concepts, and grammatical structure as well (Facione & Facione, 2010). Inductive reasoning skills on the other hand are the ability to generalize from particular evidence to a valid conclusion. It is further explained as an argument's conclusion by the assumed truth of its premises (California Academic Press, 2006). Inductive reasoning makes a determination if an argument is true or not. Scientific confirmation and experimental disconfirmation are examples of inductive reasoning.

The content validity of the CCTST is directly related to its relationship to the APA Delphi Report research. Consideration of concurrent validity must address the external criterion to be assessed. Indication of concurrent validity for the CCTST is compared to other measures of college students' aptitude and achievement. Total scores correlate significantly with college level grade point average ($r=.200$, $p<.001$), SAT verbal ($r=.550$, $p<.001$) SAT math ($r=.439$, $p<.001$), and the Nelson–Denny Reading scores ($r=.491$, $p<.001$), which are themselves described as predictors of freshman level college grade point average. Construct validity of the CCTST is supported by the pretest-posttest measure of significant gains in cases but not in controls (Facione, 1990), as well as by the high and significant correlation ($r=.667$, $p<.001$) reported between the CCTST and the CCTDI being reported in several pilot and study samples (Facione & Facione, 1992).

The Kuder-Richardson internal reliability coefficients for each of the sections of the divided sample ranged from .68-.69. This internal consistency estimate of reliability is positive. Nonhomogenous instruments designed to test a range of a complex constructs, instruments where items are intended to discriminate well between subjects, and instruments that depend upon dichotomous scoring (Facione, 1990), a level of internal reliability is considered to be .65-.75. Using these criteria, the KR-20 of .68-.69 supports the reliability to measure critical thinking skills. The difference in CCTST total scores by gender was not significant at the $p<.05$ level of probability although the overall mean scores for males (16.3) was higher than that of females (15.9) in the study involving nursing students. Gain scores were significant by gender ($p<.013$) with males showing a significantly larger gain (1.2 overall) than females (0.4 overall). Conversely, females in the sample had generally higher college grade point averages than the males.

Both descriptive and inferential statistics were used to evaluate the five research questions. Null hypotheses were tested using a series of two-way analysis of variance (ANOVA) models. The data were analyzed using SPSS statistical package.

The independent variables in the study are gender and the five academic colleges at a university in the southeast United States. The dependent variables are the scores on the dimensions of critical thinking from the CCTST. The .05 level of significance was used as the alpha level to test each hypothesis.

4. RESULTS

4.1 Research Question 1

Are there differences in the Analysis dimension of the 2009-2010 California Critical Thinking Skills Test based on college and gender? A two-way analysis of variance (ANOVA) was conducted to evaluate the effects on the Analysis dimension of the 2009-2010 California Critical Thinking Skills Test colleges (Arts and Sciences, Business and Technology, Clinical and Rehabilitative Health Sciences, Continuing Studies, Education, Nursing, and Public Health) and gender (male and female). The means and standard deviations for the Analysis dimension scores by college and gender are presented in Table 1. The ANOVA showed no significant college by gender interaction, $F(6, 1488) = .757, p = .604$, partial $\eta^2 < .01$, and no significant main effect of gender, $F(1, 1488) = .964, p = .326$, partial $\eta^2 < .01$. However, the main effect of college was significant, $F(6, 1488) = 3.012, p = .006$, partial $\eta^2 = .01$.

Because the F test for the main effect of college was significant, post hoc pairwise comparisons were conducted to determine which pairs of college means were different. A Tukey procedure was used because equal variances were assumed, $F(6, 1502) = 1.702, p = .117$. The results of this analysis showed students in the School of Nursing had a significantly higher mean on the analysis dimension ($M = 4.86$) than Business and Technology students ($M = 4.47$), Continuing Studies students ($M = 4.22$), and Education students ($M = 4.37$). None of the other pairs of means were statistically different.

4.2 Research Question 2

Are there differences in the Induction dimension of the 2009-2010 California Critical Thinking Skills Test based on college and gender? A two-way analysis of variance (ANOVA) was conducted to evaluate the effects on the Induction dimension of the 2009-2010 California Critical Thinking Skills Test at a university in the southeast United States. (Arts and Sciences, Business and Technology, Clinical and Rehabilitative Health Sciences, Continuing Studies, Education, Nursing, and Public Health) and gender (male and female). The means and standard deviations for the Induction dimension scores by college and gender are presented in Table 2. The ANOVA showed no significant college by gender interaction, $F(6, 1488) = .534, p = .783$, partial $\eta^2 < .01$. However, the main effect of college was significant, $F(6, 1488) = 4.313, p < .001$, partial $\eta^2 = .01$ and the main effect of male and female scores was significantly different $F(1, 1488) = 11.276, p = .001$, partial $\eta^2 < .01$ with the mean for males ($M = 10.26$) significantly higher than the mean for females ($M = 9.73$). Because the F test for the main effect of college was significant, post hoc pairwise comparisons were conducted to determine which pairs of college means were different. A Tukey procedure was used because equal variances were assumed, $F(6, 1502) = 1.235, p = .285$. The results of this analysis showed students in the Arts and Sciences ($M = 10.30$) and the School of Nursing ($M = 10.34$) had a significantly higher mean on the Induction dimension than Education students ($M = 9.32$). None of the other pairs of means were statistically different.

4.3 Research Question 3

Are there differences in the Deduction dimension of the 2009-2010 California Critical Thinking Skills Test based on college and gender? A two-way analysis of variance (ANOVA) was conducted to evaluate the effects on the Deduction dimension of the 2009-2010 California Critical Thinking Skills Test by colleges (Arts and Sciences, Business and Technology, Clinical and Rehabilitative Health Sciences, Continuing Studies, Education, Nursing and Public Health) and gender (male and female). The means and standard deviations for the Deduction dimension scores by college and gender are presented in Table 3. The ANOVA showed no significant college by gender interaction, $F(6, 1488) = .980, p = .437$, partial $\eta^2 < .01$, but the main effect of male and female scores were significantly different, $F(1, 1488) = 26.591, p < .001$, partial $\eta^2 < .01$ with the mean for males ($M = 8.00$) significantly higher than the mean for females ($M = 6.92$). Additionally, the main effect of college was significant, $F(6, 1488) = 4.148, p < .001$, partial $\eta^2 = .01$. Because the F test for the main effect of college was significant, post hoc pairwise comparisons were conducted to determine which pairs of college means were different. A Tukey procedure was used because equal variances were assumed, $F(6, 1502) = 1.959, p = .068$.

The results of this analysis showed students in Business and Technology ($M = 7.63$) and Arts and Sciences ($M = 7.74$) had a significantly higher mean on the deduction dimension than Clinical and Rehabilitative Health Sciences ($M = 6.28$) and Education students ($M = 6.61$). None of the other pairs of means were statistically different.

4.4 Research Question 4

Are there differences in the Evaluation dimension of the 2009-2010 California Critical Thinking Skills Test based on college and gender? A two-way analysis of variance (ANOVA) was conducted to evaluate the effects on the Evaluation dimension of the 2009-2010 California Critical Thinking Skills Test by colleges (Arts and Sciences, Business and Technology, Clinical and Rehabilitative Health Sciences, Continuing Studies, Education, Nursing and Public Health) and gender (male and female). The means and standard deviations for the Evaluation dimension scores by college and gender are presented in Table 4. The ANOVA showed no significant college by gender interaction, $F(6, 1488) = .509, p = .802, \text{partial } \eta^2 < .01$; however, the main effect of college was significant, $F(6, 1488) = 5.828, p < .001, \text{partial } \eta^2 < .01$, and the main effect of gender was significant, $F(1, 1488) = 18.553, p < .001, \text{partial } \eta^2 = .01$ with the mean for males ($M = 5.18$) significantly higher than the mean for females ($M = 4.55$).

Because the F test for the main effect of college was significant, post hoc pairwise comparisons were conducted to determine which pairs of college means were different. A Tukey procedure was used because equal variances were assumed, $F(6, 1502) = 1.953, p = .069$. The results of this analysis showed students in the College of Arts and Sciences ($M = 5.22$) had a significantly higher mean on the evaluation dimension than Business and Technology students ($M = 4.78$), Clinical and rehabilitative Health Sciences students ($M = 4.25$) and Education students ($M = 4.29$). None of the other pairs of means were statistically different.

4.5 Research Question 5

Are there differences in the Inference dimension of the 2009-2010 California Critical Thinking Skills Test based on college and gender? A two-way analysis of variance (ANOVA) was conducted to evaluate the effects on the Inference dimension of the 2009-2010 California Critical Thinking Skills Test by colleges (Arts and Sciences, Business and Technology, Clinical and Rehabilitative Health Sciences, Continuing Studies, Education, Nursing and Public Health) and gender (male and female). The means and standard deviations for the Inference dimension scores by college and gender are presented in Table 5. The ANOVA showed no significant college by gender interaction, $F(6, 1488) = 1.172, p = .319, \text{partial } \eta^2 < .01$. However, the main effect of college was significant, $F(6, 1488) = 3.413, p = .002, \text{partial } \eta^2 = .01$ and the main effect of male and female scores were significantly different $F(1, 1488) = 27.156, p < .001, \text{partial } \eta^2 < .01$ with the mean for males ($M = 8.49$) significantly higher than the mean for females ($M = 7.55$).

Because the F test for the main effect of college was significant, post hoc pairwise comparisons were conducted to determine which pairs of college means were different. The test of homogeneity of variances showed equal variances cannot be assumed, $F(6, 1502) = 3.049, p = .006$; therefore, for the Inference dimension a Tukey test could not be used. Dunnett's C , which does not assume equal variances, was used instead. Dunnett's C results showed students in the School of Arts and Sciences ($M = 8.211$) and students in Business and Technology ($M = 8.17$) had a significantly higher mean on the Inference dimension than Clinical and Rehabilitative Health Sciences ($M = 7.07$) and Education students ($M = 7.28$). None of the other pairs of means were statistically different.

5. CONCLUSIONS AND RECOMMENDATIONS

Findings from this study include implications for practice by higher education instructors addressing critical thinking skills. The results of this study indicate a need for further research and training in content delivery accompanied by critical thinking. Mapping the higher education curriculum in order to adjust course content to reduce the amount of replicated information taught in courses is highly recommended. A focus on problem-based learning, active learning, and a constructivist approach is recommended to facilitate critical thinking skills and learning that is meaningful and lasting. It is recommended that faculty be instructed in effective teaching methods that include:

1. Sharing videotaped classroom instruction where critical thinking is demonstrated.
2. Incorporating critical thinking skills in appropriate topics in classroom instruction.
3. Training higher education instructors in active learning strategies that facilitate critical thinking skills.

4. Designing course content around themes applicable to a variety of situations to encourage active learning activities and critical thinking.
5. Sharing results from the CCTST to establish a baseline and determine goals for improvement.
6. Implementing strategies of individual colleges, schools, and departments that score well on the CCTST.
7. Courses in critical thinking skills within every major.
8. Implementing a rubric for critical thinking skills within every course.
9. Mapping the higher education curriculum within each college to circumvent content

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