AN ASSESSMENT OF COGNITIVE LEVEL OF INSTRUCTION PRESENTED IN ANIMAL SCIENCE COURSES AND THE IMPACT ON DEVELOPMENT OF COGNITION IN UNDERGRADUATES

Laura White
Clemson University, lmorga2@clemson.edu

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AN ASSESSMENT OF COGNITIVE LEVEL OF INSTRUCTION PRESENTED IN ANIMAL SCIENCE COURSES AND THE IMPACT ON DEVELOPMENT OF COGNITION IN UNDERGRADUATES

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Animal and Veterinary Sciences

by
Laura Michelle White
May 2009

Accepted by:
K.D. Layfield, Committee Chair
Glenn Birrenkott, Ph.D.
Peter Skewes, Ph.D.
Mary M. Beck, Ph.D.
ABSTRACT

To be successful in life, students will need to learn to make good decisions; many of them. Quality decision making is paramount for student success in future employment and their personal lives. To make a quality decision, one must weigh all possible options and understand as many of the implications of that decision as possible. Relating options and outcomes to previous experience is advantageous. The qualities mentioned above are reliant on critical thought processes. It is imperative that graduates seeking employment possess a balanced combination of base knowledge and independent thought combined with critical thinking ability. In order to produce students with this level of cognitive capability, multiple factors must be understood. This study utilized animal science undergraduates at Clemson University and sought to determine what attributes of the students contributed to differences in critical thinking ability, whether evaluation courses developed critical thinking skills to a higher degree than a non-evaluation course over a semester, how instructors were developing critical thinking skills in the classroom through discourse and challenges, and whether participation on a judging team enhanced critical thinking ability. Students who participated on a judging team scored higher when compared to national norms and when compared to their peers at Clemson University. Evaluation courses taught at the highest levels of cognition while non-evaluation courses taught at the lowest levels of cognition, and students in evaluation courses showed a greater change in critical thinking score (P=0.0001) than students not enrolled in an evaluation course. Differences in critical thinking ability were observed for different age levels, GPA categories, and prior animal evaluation training. Animal science programs
should continue to offer opportunities to participate on a judging team and require students to take evaluation courses as part of a well rounded program of study, as evaluation course content/activities and judging team participation enhance critical thinking ability, which is a necessity for success in life.
DEDICATION

This book is dedicated to my family. Thank you all for your undying support, your love, and your patience. I could not have started this degree (let alone finish it) without your encouragement and positive outlook, thank you.
ACKNOWLEDGMENTS

I have to start with Dr. Dale Layfield, without your trust and encouragement; I would not be where I am today. I am so thankful for your energy, kindness, and the richness you brought to my project, and my life. You’re one of a kind, truly, thank you.

Dr. Mary Beck, Dr. Glenn Birrenkott, and Dr. Peter Skewes, I can’t begin to thank you enough for your perseverance and guidance, it is second to none. You all taught me far beyond the classroom and I am forever appreciative. I am truly indebted to each of you.
# TABLE OF CONTENTS

Page

**TITLE PAGE** .......................................................................................................................................................... i  
**ABSTRACT** ......................................................................................................................................................... ii  
**DEDICATION** ...................................................................................................................................................... iii  
**ACKNOWLEDGMENTS** ....................................................................................................................................... iv  
**LIST OF TABLES** .................................................................................................................................................. xi  
**LIST OF FIGURES** ................................................................................................................................................ x  

**CHAPTER**

I. **INTRODUCTION** ............................................................................................................................................. 1  
   Need for the Study ................................................................................................................................................. 2  
   Purpose and Objectives of the Study ..................................................................................................................... 2  
   Significance.......................................................................................................................................................... 3  

II. **REVIEW OF LITERATURE** ............................................................................................................................ 5  
   Critical Thinking ................................................................................................................................................ 5  
   Critical Thinking Skills ................................................................................................................................... 6  
   Assessment of Critical Thinking Ability ......................................................................................................... 7  
   Bloom’s Taxonomy ............................................................................................................................................ 9  
   Characteristics of Critical Thinking Skills ....................................................................................................... 11  
      Age .............................................................................................................................................................. 12  
      Gender ...................................................................................................................................................... 13  
      GPA and final course grade ......................................................................................................................... 13  
      Disposition toward critical thinking ability .............................................................................................. 14  
      Learning style ........................................................................................................................................... 14  
   Teaching Critical Thinking ............................................................................................................................. 18  
   Cognitive Level of Academic Classrooms ...................................................................................................... 22  
   Cognitive Abilities of Students ....................................................................................................................... 24  
   Evaluation Courses ........................................................................................................................................ 26  
   Conclusions .................................................................................................................................................... 28
### Table of Contents (Continued)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>III. LEVEL OF ACADEMIC CHALLENGES PROVIDED TO STUDENTS IN SELECTED CLASSROOMS IN THE COLLEGE OF AGRICULTURE</strong></td>
<td>29</td>
</tr>
<tr>
<td>Abstract</td>
<td>29</td>
</tr>
<tr>
<td>Introduction</td>
<td>30</td>
</tr>
<tr>
<td>Cognitive Level of Academic Classrooms</td>
<td>30</td>
</tr>
<tr>
<td>Cognitive Abilities of Students</td>
<td>33</td>
</tr>
<tr>
<td>Evaluation Courses</td>
<td>34</td>
</tr>
<tr>
<td>Methods</td>
<td>36</td>
</tr>
<tr>
<td>Population</td>
<td>36</td>
</tr>
<tr>
<td>Procedure</td>
<td>37</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>39</td>
</tr>
<tr>
<td>Data analysis</td>
<td>41</td>
</tr>
<tr>
<td>Results</td>
<td>41</td>
</tr>
<tr>
<td>Discussion and Conclusions</td>
<td>44</td>
</tr>
<tr>
<td><strong>IV. COMPARATIVE DEVELOPMENT OF CRITICAL THINKING SKILLS IN ANIMAL SCIENCE UNDERGRADUATES WHO ENROLL IN EVALUATION COURSES</strong></td>
<td>47</td>
</tr>
<tr>
<td>Abstract</td>
<td>47</td>
</tr>
<tr>
<td>Introduction</td>
<td>48</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>49</td>
</tr>
<tr>
<td>Evaluation Courses</td>
<td>50</td>
</tr>
<tr>
<td>Methods</td>
<td>51</td>
</tr>
<tr>
<td>Population</td>
<td>52</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>52</td>
</tr>
<tr>
<td>Data analysis</td>
<td>52</td>
</tr>
<tr>
<td>Results</td>
<td>53</td>
</tr>
<tr>
<td>Discussion and Conclusions</td>
<td>54</td>
</tr>
<tr>
<td><strong>V. DIFFERENCES WITH DEMOGRAPHIC CHARACTERISTICS OF ANIMAL SCIENCE UNDERGRADUATES RELATING TO CRITICAL THINKING ABILITY</strong></td>
<td>57</td>
</tr>
<tr>
<td>Abstract</td>
<td>57</td>
</tr>
<tr>
<td>Introduction</td>
<td>59</td>
</tr>
<tr>
<td>Critical Thinking Skills</td>
<td>60</td>
</tr>
<tr>
<td>Demographic Descriptors of Critical Thinking Skills</td>
<td>61</td>
</tr>
</tbody>
</table>
Table of Contents (Continued)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>63</td>
</tr>
<tr>
<td>Population</td>
<td>63</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>64</td>
</tr>
<tr>
<td>Data analysis</td>
<td>64</td>
</tr>
<tr>
<td>Results</td>
<td>65</td>
</tr>
<tr>
<td>Age</td>
<td>65</td>
</tr>
<tr>
<td>Classification</td>
<td>66</td>
</tr>
<tr>
<td>Gender</td>
<td>66</td>
</tr>
<tr>
<td>GPA</td>
<td>67</td>
</tr>
<tr>
<td>Previous judging experience</td>
<td>68</td>
</tr>
<tr>
<td>Discussion and Conclusions</td>
<td>69</td>
</tr>
</tbody>
</table>

**VI. APPRAISAL OF CRITICAL THINKING SKILLS**

**IN ANIMAL SCIENCE UNDERGRADUATES WHO PARTICIPATED ON A COMPETITIVE JUDGING TEAM** 72

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>72</td>
</tr>
<tr>
<td>Introduction</td>
<td>73</td>
</tr>
<tr>
<td>Methods</td>
<td>75</td>
</tr>
<tr>
<td>Population</td>
<td>76</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>76</td>
</tr>
<tr>
<td>Collection</td>
<td>77</td>
</tr>
<tr>
<td>Data analysis</td>
<td>78</td>
</tr>
<tr>
<td>Results</td>
<td>78</td>
</tr>
<tr>
<td>Discussion and Conclusions</td>
<td>79</td>
</tr>
</tbody>
</table>

**VII. FINAL CONCLUSIONS AND RECOMMENDATIONS** 81

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implications</td>
<td>82</td>
</tr>
<tr>
<td>Future Studies</td>
<td>88</td>
</tr>
</tbody>
</table>

**APPENDICES** 91

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Institutional Review Board of Clemson University Approval</td>
<td>92</td>
</tr>
<tr>
<td>A-1 IRB approval for research</td>
<td>92</td>
</tr>
<tr>
<td>B: Forms utilized in studies</td>
<td>93</td>
</tr>
<tr>
<td>B-1 Questionnaire for students taking the WGCTA exam</td>
<td>93</td>
</tr>
<tr>
<td>B-2 Methods for evaluating discourse and challenges</td>
<td>94</td>
</tr>
<tr>
<td>B-3 Cognition record sheet for challenges</td>
<td>95</td>
</tr>
</tbody>
</table>

**REFERENCES** 96
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Animal and Veterinary Science courses and list of challenges</td>
<td>42</td>
</tr>
<tr>
<td>3.2</td>
<td>Percentage of cognitive level of instruction, challenges, and final course grade of Animal and Veterinary Sciences courses</td>
<td>44</td>
</tr>
<tr>
<td>4.1</td>
<td>Average pre test scores for WGCTA constructs of (N) non evaluation and (E) evaluation courses</td>
<td>53</td>
</tr>
<tr>
<td>4.2</td>
<td>Average post test scores for WGCTA constructs of (N) non evaluation and (E) evaluation courses</td>
<td>54</td>
</tr>
<tr>
<td>5.1</td>
<td>First order interactions of demographic variables</td>
<td>65</td>
</tr>
<tr>
<td>5.2</td>
<td>Results for differences in critical thinking score with regard to age</td>
<td>66</td>
</tr>
<tr>
<td>5.3</td>
<td>ANOVA results for differences in critical thinking score with regard to classification is school</td>
<td>66</td>
</tr>
<tr>
<td>5.4</td>
<td>Results for differences in critical thinking with regard to gender</td>
<td>67</td>
</tr>
<tr>
<td>5.5</td>
<td>ANOVA results for differences in critical thinking with regard to GPA</td>
<td>67</td>
</tr>
<tr>
<td>5.6</td>
<td>Tukey post hoc results showing differences in critical thinking score with regard to GPA category</td>
<td>68</td>
</tr>
<tr>
<td>5.7</td>
<td>Results for differences in critical thinking with regard to previous judging experience</td>
<td>69</td>
</tr>
<tr>
<td>6.1</td>
<td>Self reported demographic information for (J) judging team members and (N) control group of students</td>
<td>78</td>
</tr>
<tr>
<td>6.2</td>
<td>Mean WGCTA scores for judging team members and control, including standard deviation and Z-score</td>
<td>79</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Critical thinking proficiency of Clemson University students in 2007/2008.</td>
<td>26</td>
</tr>
<tr>
<td>3.1</td>
<td>List of indicators for Bloom’s Taxonomy of cognitive development</td>
<td>40</td>
</tr>
</tbody>
</table>
CHAPTER ONE
INTRODUCTION

It is imperative that animal science graduates possess a balanced combination of base knowledge and independent thought combined with critical thinking ability (Spady, 1994). These elements are attributes of critical thinking and are essential for job and professional school placement, and student success, although some students do not acquire them to the fullest extent. Previous research shows that senior students in a college of agriculture scored lowest on a critical thinking ability construct when compared to basic cognitive and applications abilities (Torres and Cano, 1995). Graduating a good thinker is not only advantageous for the university, but for the nation as a whole.

Universities must find ways to promote critical thinking enhancement in all undergraduate students. Animal science departments might have an advantage to create critical and higher order thinking in the form of multiple courses that involve evaluation of livestock animals. Evaluation courses (live animal, meat, etc.) have remained an integral part of animal science programs throughout the country. Evaluation courses teach students generally accepted criteria for evaluating a particular animal, industry standards, and rules to compare multiple animals; and they emphasize students’ abilities to defend their judgments both in writing and orally. Many believe that students in an evaluation class gain needed and useful experience in analytical and critical thinking, judgment, and written and oral communication (Potter, nd.). These attributes of evaluation courses are believed to contribute to higher order thinking.
Need for the Study

Undergraduate curricula across the country should be focused on producing students who possess the tools to be successful as a professional in the workforce. Critical thinking is an essential tool graduates should possess. Curriculum committees and administrations must have a solution to ensure students are receiving the kind of education that will give them these necessary tools. A solid foundation of understanding is needed before changes in curricula can be made. Understanding how critical thinking is encouraged, how it is already being created, and how best to enhance critical thinking skills, are essential. Instructors must recognize their pivotal role in creating and enhancing the critical thinking ability of their students. Instructors should be provided with information that will help them make critical thinking in the classroom a reality and allow the aforementioned goals to be successful. To accomplish this, we must fully understand the current critical thinking ability of undergraduates and the contributions current teaching practices make to enhance critical thinking ability.

Purpose and Objectives of the Study

The purpose of this study was to better understand critical thinking attributes and ability in undergraduate students. This study sought to identify a relationship between evaluation courses and higher order thinking; more specifically, to quantify the improvement or regression in critical thinking ability of students enrolled in an evaluation course. An additional purpose was to investigate differences in demographic information of students related to their critical thinking skills. The objectives of the study were as follows:
1. Quantify the frequency and describe the level of academic challenges provided to students in selected classrooms in a college of agriculture.

2. Compare development of critical thinking skills in animal science undergraduates who enroll in evaluation courses to students not enrolled in an evaluation course.

3. Evaluate differences within demographic characteristics of animal science undergraduates relating to critical thinking ability.

4. Appraise critical thinking skills in undergraduate students who participate on a competitive collegiate judging team.

**Significance**

This study has the potential to impact the instructors participating in the research process and the students they teach. Instructors will better understand student cognitive levels of thought required to interact and respond to teaching and testing once results from the study are revealed. Instructors can then determine how the student is being evaluated and earning the final grade with regard to cognitive level of thought. Once the instructor is aware of the significance of their grading decisions, action can be taken to encourage all levels of thought including higher order thinking that will be ideal to the cognitive goals for the course. Educators should be encouraged to develop students in all areas of higher order thinking and create an environment that facilitates higher levels of cognitive development. With the wealth of knowledge available through computers and the media, it is increasingly important to teach students to master the thinking and reasoning skills needed to utilize this information (Meyers, 1988). In order to produce
students with this level of cognitive capability, challenges that foster higher levels of learning should be provided in academic classrooms. This will benefit not only the students in all aspects of their lives, but also their future employers and lead to a more knowledgeable and thinking electorate.

Likewise, curriculum committees will better appreciate the impact evaluation courses have when included as part of a well-rounded program of study. Since evaluation courses are under scrutiny for their effectiveness, a more defined view of evaluation courses and teaching styles and how they affect students will empower curriculum committees to make a more informed decision when determining the usefulness of evaluation courses. Determining the most functional courses for an undergraduate education is a challenging task, and solid research that defines or refutes specific courses is a must.
CHAPTER TWO

REVIEW OF LITERATURE

Challenges faced by American colleges and universities are numerous, including preparation of individuals who are capable of higher order thinking. A student exhibiting higher order thinking is proficient at making independent decisions and thinking critically. Producing a person who is capable of these important functions is no easy task and has been the topic of much discussion and deliberation. Professors and instructors at today’s universities must challenge students to perform at higher levels of cognition (Taylor & Kauffman, 1983). Peters et al. (2002) states that students must be able to apply and integrate previously learned discrete facts to support their viewpoints in order to develop critical thinking skills.

Critical Thinking

Critical thinking can be traced back to a vision by Socrates that utilizes probing questioning to force a person to justify their claims (The Critical Thinking Community, 2008). Critical thinking has long been defined in a narrow frame of reference such as a form of logic, or a watered down version of the scientific method (Meyers, 1988). Many researchers use the term synonymously with higher order thinking (Cano, 1993; Whittington & Newcomb, 1993; Whittington 1995, McCormick & Whittington; 2000). Others dispute this claim and argue that critical thinking is the act of a person taking charge of their own thinking (Ricketts, 2003). Still others believe it is the ability to formulate generalizations, entertain new possibilities, and suspend judgment (Meyers, 1988).
Critical Thinking Skills

Torres and Cano (1995) found that senior students enrolled in a college of agriculture program were graduating with less than adequate cognitive skills that are vital to solve problems, make decisions, and think critically. Producing a well-rounded student capable of independent thought, decision making, and critical thinking ability mandates that each of the categories of the Bloom’s Taxonomy hierarchy (discussed in a later section) be mastered (Bloom et al., 1956).

Critical thinking skills have been widely disputed, especially in recent years. Ricketts et al. (2005) and a panel of experts determined that the skills required for critical thinking were interpretation, analysis, evaluation, inference, explanation, and self-regulation. Interpretation involves a clear understanding of experiences, beliefs, procedures, rules, etc. Analysis requires not only the understanding of multiple facets of an issue, but also the relationship between each idea. Evaluation requires the student to assess the situation, compare it to known criteria, and determine its strength. Inference is the ability to discriminate between varying degrees of truth of assumptions drawn from known information. Explanation is the ability to state and justify an outcome based on the above mentioned skills. Finally, self-regulation is the ability of the student to ensure that they are engaging in critical thinking. Each of the skills mentioned is a building block for the next. A student cannot simply begin thinking critically for the first time at the evaluation or even the analysis element. Possessing a strong base of knowledge and being able to refer to it when needed facilitates critical thought processes and achievement of higher levels of cognition (Spady, 1994).
To master each of the aforementioned skills, an instructor must be taught to comprehend the different levels of cognition. The instructor must model critical thinking and higher order thinking for the students such that they may truly grasp the material through imitation or observational learning. Albert Bandura, in his social cognitive theory, cited the students’ own self-efficacy about a skill as being integral in determining whether they will model that skill (Kail and Cavanaugh, 2007). Because of this, it is important to reward and encourage students who are just beginning to utilize higher levels of cognition, acknowledging independent thought and decision making. Identifying appropriate solutions to problems is recognized as the last step of information processing during adolescence, which implies undergraduate students are not well versed in making quality decisions when they enter college (Kail and Cavanaugh, 2007). The typical undergraduate cannot be expected to be able to think at high levels of cognition without the appropriate tools that should be provided by an instructor, which include a logical flow of events that will help the student operate at high levels of cognition.

**Assessment of Critical Thinking Ability**

Understanding critical thinking is paramount to evaluating it. The Watson-Glaser Critical Thinking Appraisal (WGCTA) exam evaluates critical thinking ability through constructs, including: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments (Watson and Glaser, 1980). These subsets are synonymous with higher order thinking defined by Bloom et al. (1956), and similar to those identified by Ricketts et al. (2005). The identification of these subsets for the evaluation of critical thinking suggests that the definition for critical thinking is not far from that of higher
order thinking. The WGCTA seeks to provide an estimate of an individual’s standing on a composite of attitude, knowledge, and skills by means of evaluating the student’s ability to think critically in five categories; 1) Inference, 2) Recognition of Assumptions, 3) Deduction, 4) Interpretation, and 5) Evaluation of Arguments. All five categories are equally weighted and the entire test is on an 80 point scale. The **Inference** section requires the test taker to discriminate among degrees of truth or falsity of inferences drawn from given data. **Recognition of Assumptions** requires the ability to recognize unstated assumptions or presuppositions in given statements or assertions. **Deduction** entails determining whether certain conclusions necessarily follow from information in given statements or premises. **Interpretation** consists of weighing evidence and deciding whether generalizations or conclusions based on the given data are warranted. Finally, **Evaluation of Arguments** distinguishes between arguments that are strong and relevant or weak and irrelevant. The components of the assessment tool include problems, statements, arguments, and interpretations of data. All components are aimed at mimicking real-world situations one might encounter at work, school, or in newspaper and magazine articles. Validity and reliability have been established for the WGCTA by the respective authors with a reliability coefficient of 0.74 (Watson & Glaser, 1980). Another study that utilized the WGCTA and the DCAT exams for high school students (n=384) measured the WGCTA as yielding a reliability coefficient of 0.78 (Cano, 1993). Researchers in Texas found that the WGCTA exam remained reliable and consistent when given to undergraduate and graduate students (n=58) at Southwestern State University (Gadzella et al., 2005).
Another commonly used exam for quantifying higher order thinking is the Developing Cognitive Abilities Test (DCAT) by American College Testing. The DCAT consists of subsets that include basic abilities, application abilities, and critical thinking abilities. The DCAT subsets are equivalent to the hierarchal nature of Bloom’s Taxonomy (1956) and comparable to those branded by Ricketts et al. (2005). The DCAT focuses on all levels of cognition, but not specifically the ability to think critically. The WGCTA exam concentrates solely on evaluating critical thinking ability.

The California Critical Thinking Disposition Inventory (CCTDI) surveys the dispositional aspects of critical thinking. The CCTDI determines the extent to which the respondent agrees or disagrees with statements expressing beliefs, values, attitudes and intentions that relate to the reflective formation of reasoned judgments. The CCTDI measures the "willing" dimension in the expression "willing and able" to think critically.

**Bloom’s Taxonomy**

Bloom’s Taxonomy outlines a classification of education outcomes by dividing the cognitive domain into six categorical levels. The organization of these major classes of cognitive domain represents a hierarchical order such that the objectives in one class are likely to make use of and be built on the behaviors found in the previous classes (Bloom et al., 1956). Bloom’s organization of cognitive domain begins with the most basic and follows a hierarchy to the most difficult: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956).

**Knowledge** involves the recall of specific terminology, facts, methods and processes. The objectives of knowledge emphasize remembering material previously
learned. Action terms to test knowledge abilities include list, define, label, match, and designate (McCormick and Whittington, 2000).

**Comprehension** represents the lowest level of understanding. Comprehension dictates that an individual understand information that is being communicated and can make use of the material without being able to relate it to other material or seeing the full implications of the information (Bloom et al., 1956). Comprehension also prescribes that a student be able to process learned information. Action terms to test comprehension abilities include explain, paraphrase, summarize, rewrite, and give examples (McCormick and Whittington, 2000).

**Application** encompasses the use of general ideas, rules or methods in particular and concrete situations. Further abstractions may be technical principles, ideas, and theories that must be remembered and applied (Bloom et al., 1956). Action terms to test application abilities include compute, demonstrate, use, predict, discover, solve, and apply (McCormick and Whittington, 2000).

**Analysis** is the breakdown of a communication into constituent elements such that the relative hierarchy of ideas is made clear and/or relations between the ideas expressed are made explicit (Bloom et al., 1956). Action terms to test analysis abilities include consider, differentiate, discriminate, relate, diagram, and distinguish (McCormick and Whittington, 2000).

**Synthesis** involves coupling elements previously learned to form a whole. Processes include working with pieces, parts, and elements, and arranging them is such a way as to constitute a pattern or structure not there before (Bloom et al., 1956). Action
terms to test synthesis abilities include create, compose, produce, and develop (McCormick and Whittington, 2000).

**Evaluation** focuses on judgments about the value of material and methods for given purposes, including quantitative and qualitative judgments about the extent to which material and methods satisfy criteria. Evaluating criteria involves using a set standard of appraisal (Bloom et al., 1956). Action terms to test evaluation abilities include justify, compare, contrast, evaluate, and interpret (McCormick and Whittington, 2000).

**Characteristics of Critical Thinking Skills**

Multiple predictors have been studied to identify their influence on critical thinking abilities. The available data are variable to say the least and, in some cases, incomplete. Some possible factors include age, gender, GPA, learning style, and classification level in school. Another contributor to critical thinking ability would logically be disposition and attitude toward critical thinking in general. Overall involvement in on-campus clubs, interaction with faculty and peers, and employment, has been shown to be positive predictors of critical thinking ability in multiple studies, cited in Gellin (2003). On-campus living and interaction with peers showed the highest positive correlation of extracurricular activities reviewed, with employment a close second. These findings support undergraduate immersion in the college experience as a crucial ingredient for critical thinking. Being able to predict approximate critical thinking ability and generalize it across a student population is advantageous. If
differences between types of students exist, resources could be focused to reach a larger number of students in the best way possible.

Age

It would seem logical that as age and maturity increase, the ability to think at higher cognitive levels would also increase. Surprisingly, in the majority of studies, age shows no significant effects on critical thinking ability (Facione, 1990; Facione, 1991; Jenkins, 1998; Rudd et al., 2000; and Ricketts and Rudd, 2005). Cano (1993) found conflicting results regarding the influence of age on the cognitive level of performance associated specifically with critical thinking abilities. Cano studied the critical thinking ability of Ohio agricultural education high school students (n=384), using the Developing Cognitive Abilities Test (DCAT) and the Watson-Glaser Critical Thinking Appraisal (WGCTA) exams. Cano (1993) reported significant (P<0.03) differences between senior students’ and freshman/sophomore students’ scores (48.71 and 43.81/47.45, respectively) on the DCAT. However, the WGCTA showed no effects of age on final scores using the same students. Previously, Cano and Martinez (1991) observed similar results of increased cognitive score with regard to age/grade level using the DCAT to test high school agriculture education students (n=385). It is important to note that the DCAT measures multiple constructs and characteristics of higher order thinking, including critical thinking, while the WGCTA only measures a student’s ability to think critically. It would seem that age may be an indicator of ability and competence for higher order thinking in general and not specifically of critical thinking ability. Both tests are considered to be accurate, valid, and appropriate.
Gender

If gender differences exist for ability to think critically, perhaps adjustments need to be made by secondary and post-secondary schools to facilitate learning. In regards to critical thinking ability, multiple studies observed no significant influence of gender on ability to think critically (Torres & Cano, 1995, 2006; Ricketts & Rudd 2005; and Friedel et al.). In contrast, a study by Wilson (1989) who observed college freshmen (n=203) using the WGCTA exam determined that gender was a significant indicator of critical thinking skill.

With regard to disposition to think critically, Rudd et al. (2000) observed significant differences ($\alpha = 0.03$) of mean score for females (n=110, avg. score = 297.8) and males (n=60, avg. score = 288.1) on the CCTDI. It is important to note that the CCTDI measures attitude and disposition of students that are likely contribute to higher order thinking, not actually critical thinking ability. Other studies determined that gender was a useful variable to predict variance in attitude towards critical thinking ability (Walsh, 1996, and Rudd et al., 2000) for males and females.

GPA and final course grades

It is reasonable to assume that students with a higher ability to think critically are also higher scoring on standardized tests and have higher grade point averages (GPA). GPA has been a significant predictor of critical thinking skill in multiple studies; and in some cases, the only useful predictor (Giancarlo, 1996; Jenkins, 1998; and Thompson, 2001). GPA has been shown to be a factor in at least portions of critical thinking constructs on the CCTDI and researcher-developed critical thinking skills tests.
(Giancarlo and Facione, 2001 and Ricketts and Rudd, 2005). Shann et al. (2006) examined undergraduate students (n=63) enrolled in a Live Animal and Meat Evaluation course at the University of Missouri-Columbia. They determined that improvements made in the final scores of the WGCTA exam from the first class day to the final class day were similar for students who received an A, B, or C, for their final course grade. Therefore, final course grade does not appear to be a good indicator of improvement in critical thinking ability over the course of a semester in an evaluation course (Shann et al., 2006).

**Disposition toward critical thinking**

In a five year study, Facione et al. (2000) observed students and professionals (n=7,926) in 50 different collegiate programs. Participants included 10th graders, accounting professionals, nursing professionals, and college students. Researchers identified relationships between critical thinking ability and demographic factors, including individual attitude toward critical thinking ability. A significant (P < 0.01) weak positive correlation (r = 0.201) was found between overall disposition and critical thinking ability of students. These findings suggest that increasing critical thought process in the classroom would involve more than simply teaching for critical thinking. An educator must also foster a personal desire to fortify critical thinking ability.

**Learning style**

Students have different tendencies to learn; an idea that has been widely accepted since the teachings of Socrates, Plato, and Aristotle. The idea that because everyone learns differently, we should determine learning styles of our pupils and adapt curricula
to accommodate their preferred style of learning, has gained strength, as evidenced by the multitude of books on the subject. However, since classrooms are made up of students of a variety of learning styles, it makes more sense to focus instruction on many learning styles where everyone will have an equal opportunity to succeed.

Many instructors believe that student learning style is a hinge to success for teachers and students alike. Quality of teaching is in part determined by an individual’s understanding of different learning styles and the ability to appeal to each (Butler and Pinto-Zipp, 2006). Personality, information processing, social interaction, and instructional methods are the characteristics around which learning styles of students are generally studied (Claxton and Murrell, 1987). Witkin (1981) determined that students fit into two categories, field-dependent or field-independent. Field-dependent learners typically learn more readily in an informal environment, have a more global perspective, and are more social. Field-independent learners can learn well in formalized settings and are better able to focus on individual components of the subject or task at hand. Many other definitions and categories of learning styles exist, and theoretical perspectives and instruments to test for them are readily available.

Torres and Cano (1995) suggest that learning style is indeed a significant variable that educators need to be familiar with when promoting critical thinking ability. In contradiction, Rudd et al. (2000) attempted to look for connections between learning style defined by Witkin (1981) and critical thinking dispositions of students (n=174) enrolled in the College of Agriculture and Life Sciences at the University of Florida. Researchers found no correlations between critical thinking disposition and learning style, such that
learning style does not appear to be associated with a student’s disposition to think critically. Of the students studied, 30.5% had a low disposition to think critically, and only 1.7% of students had a high disposition to think critically (Rudd et al., 2000).

With regard to ability to think critically and a student’s preferred learning style, researchers found an interesting correlation (Myers and Dyer, 2006). Students (n=135) completed the Cornell Critical Thinking Test (CCTT) to determine critical thinking skills of each student. Further, students completed the Gregorc Style Delineator, a standardized instrument to assess preferred learning styles of each student. The Gregorc separates learning styles into combinations of four categories: concrete sequential, concrete random, abstract sequential, and abstract random. Abstract sequential learners scored significantly (P=0.001) higher than all other learning styles on CCTT (Myers and Dyer, 2006).

Most research shows that educators can become more effective teachers by assessing their students’ preferred learning styles (McAndrews et al., 2005; Butler & Pinto-Zipp, 2006; Choi et al., 2008; Lopez & Schroeder, 2008). This assessment can help in planning the curriculum and selecting appropriate instructional methods to utilize throughout the semester. Other researchers argue that no benefits exist for matching instruction to preferred learning styles (Olson, 2006; Dembo and Howard, 2007; Sun et al., 2008). Dembo and Howard (2007) claim that learning style tests are not valid or reliable instruments for assessing learning style in students. They assert that there is no evidence of positive pedagogical impact on education when learning styles are taken into account. These researchers agree that teaching toward students’ preferred learning styles
has no solid basis in research, citing decreased effort and performance in the classroom as possible outcomes.

Some might argue that the college experience prepares an individual for the real world, where the supervisor does not care at the end of the day what learning style an employee possesses, but rather that the job is done (Olson, 2006; Dembo & Howard, 2007; Sun et al., 2008). In essence, sink or swim; adapt or risk failure. Some might view this approach in a collegiate setting as harsh, especially since higher education seeks to prepare students to become the independent thinkers that they typically aren’t when they arrive their freshman year. Even so, with the multitude of learning style descriptions, exams, and theories, combined with the host of teaching styles and multimedia options available to an instructor, it is impossible to accommodate every student in a classroom at one time (Dembo & Howard, 2007). Olsen (2006) agrees that a more cohesive response would be to challenge students utilizing all of the different methods of teaching throughout the semester, such that equal chances to succeed are given across all students’ learning styles. A positive solution to teaching students at all levels of base knowledge and of different learning styles includes a need to scaffold information between concrete and more abstract representations (Olsen, 2006).

With regard to method of instruction, student learning style, and critical thinking ability, research is sharply divided. While different learning styles do exist, using one classification method to describe them is impossible. Further, appealing solely to a certain learning style is not only difficult, but an erroneous endeavor that will potentially only make it harder for the student with that learning style to function in the real world,
mainly because the real world is not as accommodating (Dembo and Howard, 2007). At the end of the day, an instructor is charged with helping ALL students reach the objectives and goals of each course and maximize the potential to develop critical thinking skills (Olsen, 2006).

Teaching Critical Thinking

While the ability to think with the tools (brain-power) provided is instinctive, the way we interpret the full picture is learned (Meyers, 1988). A teacher well versed in incorporating into a class lecture the necessary elements to foster critical thinking skills may still have trouble incorporating the methodology to develop critical thinking ability in students. Significant learning and higher order thinking generally take place when students are motivated by wonder, mystery, and personal interest (Meyers, 1988). To accomplish this, instructors should promote questioning, exploration and synthesis, rather than simply passing information (Schillo, 1997).

A student must be taught at different levels of cognition to master thinking critically. An instructor must utilize class material while modeling critical thinking and higher order thinking for the students, such that they truly grasp critical thinking skills related to class material through imitation and observational learning. Albert Bandura believed that the students own belief in their ability as it relates to a particular skill is integral in determining whether they will model that skill (Kail & Cavanaugh, 2007). It is important to reward and encourage students continuously as they are practicing new abilities, such that they may eventually be able to reproduce the skill on their own and feel confident in doing so. The typical undergraduate cannot be expected to be able to
think at high levels of cognition without the appropriate sequence of methods that ideally should be developed by an instructor (Kail & Cavanaugh, 2007).

Even though lecture style classrooms are found throughout colleges and universities, lecture style teaching has been shown to inhibit critical thinking development because instructors teach it only implicitly or not at all (Meyers, 1988 and Friedel et al., 2006). Developing general critical thinking abilities can begin by general problem-solving and logic courses where students are forced to think through problems to find solutions. These courses have students communicate an objective and analyze the situation utilizing sound arguments and judgments (Meyers, 1988). However, research has shown that logic and problem solving may not be the best mode for cultivating critical thinking, as there is little carryover between comprehension of skills of logic and applying critical thinking skills to another discipline (Hudgins, 1978; McPeck, 1981).

Students should be armed with the appropriate tools or methodology to tackle challenges that will require them to think critically in order to solve the problem. When teaching critical thinking, it is important to apply a logical flow of events for students to easily understand and master, such that they can be applied habitually to solve problems the student will face throughout life (Friedel et al., 2006). A clear picture that is easy to interpret will decrease confusion and frustration in students and teachers alike. An approach that can be applied to most subject matter follows:

**Interpretation** – basic learning of facts, formulas, and definitions of criteria;

**Analysis** – visual assessment of how a model fits the previously learned facts, formulas, and/or definitions of criteria, and
Evaluation – independent decision making, classifying model(s) based on previous analysis.

Myers (1988) asserts that when teaching, it is important to avoid overwhelming students with inane details of the critical thinking process. It is not necessary for students to fully understand a definition of critical thinking to exhibit critical thought. Instructors should focus on basic disciplinary foundations (terms, concepts, issues, methodologies, etc.) and help foster cognitive development by providing general ways to structure newly found knowledge and question it, in order to create an outline for analysis (Meyers, 1988). This can be followed with visualization of the thinking process, determining limitations, and attempting to expand the thinking process beyond attitudes and perceptions based on limited life experiences. This type of process requires maturity, but is essential as students cannot learn to think critically until they can set aside their own visions of truth and reflect on alternatives (Meyers, 1988). Meyers also suggests beginning the academic semester by asking, “What do I want students to know and what do I want them to be able to do by the end of this course?” This forces a teacher to concentrate on central issues such that content can be chosen to clarify the issues. Another necessary element is student-student and student-teacher interactions, including debate and questioning, which can help foster critical thinking development (Meyers, 1988). A study by Smith (1977) demonstrated that student participation, coupled with teacher encouragement and peer interaction, correlated positively with improved critical thinking scores. This scenario can be difficult to produce as it takes making time available for students to raise questions and respond to lectures, as well as planning and
forethought on the teacher’s part. Even so, the scenario described by Smith (1977) is paramount to developing critical thinking ability in students.

An exercise to foster critical thinking in students (n=137) was employed by Peters et al. (2002) at Michigan State University and the University of Missouri-Columbia. Critical interactive thinking exercises (CITE) were utilized in a reproductive physiology course over a three year period. Students were given a question/topic in class relating to a somewhat unknown topic and asked to prepare a typed composition that formulated a hypothesis or approach to the problem for the following class period. Small group discussions followed by a whole class discussion were then employed. Students (95.6%) self-reported that CITE enhanced their critical thinking skills and the activity was a positive experience (Peters et al., 2002).

Friedel et al. (2006) attempted to determine whether overtly teaching for critical thinking would influence critical thinking skills of undergraduates (n=58) enrolled in two similar agri-science courses covering biotechnology concepts. In one course, the instruction method centered on overtly teaching for critical thinking; the second course served as the control, where normal lecture discourse was applied. To overtly teach for critical thinking, students were taught components of critical thinking and then asked to utilize learned skills during class when focusing on new material. There was a larger (P=0.03) increase (pre-test = 187.55 vs. post-test = 196.15) in the post-test score for the course that utilized overt teaching concepts compared to the course that utilized conventional teaching methods (pre-test = 171.50 vs. post-test = 171.83) (Friedel et al.,
This is a positive finding for teachers, as a simple understanding by the student of critical thinking processes can enhance critical thinking development.

**Cognitive Level of Academic Classrooms**

If producing a well-rounded student capable of higher order thinking is an end goal for higher education, then this goal begins in the classroom. Students must be taught and challenged at all levels of cognition to increase understanding and retention. Research shows that 84.2% of challenges provided by professors in a college of agriculture were at the knowledge and comprehension levels of Bloom’s Taxonomy, the lowest levels of cognition (Ewing et al., 2006).

Whittington and Newcomb (1993) observed ten professors in a College of Agriculture who taught freshman through senior level courses. Professors were surveyed before the start of the fall semester to determine their aspired goals for teaching at different levels of cognition. Aspired goals for discourse and testing were 71% and 74%, respectively, at the two lowest levels of Bloom’s Taxonomy. Courses and assignments were evaluated throughout the semester and assessed for level of cognition. Researchers found that 95% of discourse and 80% of testing challenged the students at the lowest levels of Bloom’s Taxonomy (Whittington and Newcomb, 1993). Professors participating in Whittington and Newcomb’s (1993) study failed to reach their aspired cognitive level for discourse and testing by as much as 30%.

Using these categories, participants were evaluated to determine the level they aspired to teach to, the level of cognition instructors were actually teaching, attitudes toward teaching at higher levels of cognition, and relationships between the above objectives. Researchers recorded that instructors aspired to aim 30% of teaching time at the remembering level and 24% at the processing level. The creating and evaluating levels ranged from 0 to 50% and 0 to 60%, respectively. Participants also indicated positive attitudes for teaching at higher cognitive levels. Observed cognitive level of instruction was as follows: 43% remembering, 55% processing, 1.5% creating (range 0 to 6%), and < 1% evaluating.

Researchers in Ohio observed nine classrooms in a college of agriculture over a quarter and found that professors offered a mean of 5.8 challenges to students, with a mean of 2.7 different types of challenges (Ewing et al., 2006). This shows that professors offered multiple challenges of the same type to students (ie: 10 quizzes, 4 tests). Similarly, researchers in Pennsylvania (McCormick and Whittington, 2000) utilized Bloom’s Taxonomy and observed a mean of 13.2 academic challenges provided to students with a mean of 4.6 different types of challenges. McCormick and Whittington (2000) observed faculty members (n=11) from nine departments in the College of Agricultural Sciences to describe types and frequency of academic challenges provided to students, determine the cognitive level of each academic challenge, and assess the value of each challenge to final grade. Levels observed for different challenges were 10.7% at the knowledge level, 17.7% at comprehension, 22.3% at application, 15.8% at analysis, 16.7% at synthesis, and 16.4% at the evaluation level. Researchers determined that,
overall, 28.4% of challenges were issued at the lower levels of cognition (knowledge and comprehension) and 71.6% were issued to students at higher levels of cognition (analysis, application, synthesis, and evaluation). Finally, researchers looked at tabulation of final course grade. Higher and lower levels of cognition contributed equally to students’ final grades (50.4% and 49.6%, respectively). It seems unbalanced that 71.6% of course work would be presented at higher levels of cognition (a common goal of educators), but only represent 50.4% of the students final grade.

Higher levels of cognitive thought processes will better equip students to face the challenges of an ever changing society. To achieve this, teaching students to think at the highest levels of cognition begins in the classroom and is backed up by students practicing higher order thinking on assignments, and finally exhibiting higher order thinking on exams. Logically, grading schemes should reflect the amount of emphasis placed on higher order thinking in the classroom and when completing challenges. Whittington and Newcomb (1993) challenge American professors to test less at the remembering, or lowest level of cognition, and model for students the higher order thinking during discourse.

Cognitive Abilities of Students

Current cognitive abilities of students must be understood so that improvements can be made. Torres and Cano (1995) tested senior students (n=196) enrolled in a college of agriculture using the DCAT, which examines three cognition levels that are congruent with the five lowest levels of Bloom’s Taxonomy (does not include evaluation). Researchers observed higher scores for the basic Cognitive abilities section and the
Application abilities section when compared to the Critical Thinking abilities section (19.8 and 20.1 vs. 16.8, respectively) (Torres and Cano, 1995).

Researchers in Florida (Ricketts and Rudd, 2005) used a researcher developed critical thinking skills test for selected youth leaders (n=207) in the National FFA Organization. The test examined three critical thinking skills identified by a panel of experts: analysis, evaluation, and inference. Mean scores for analysis, evaluation, and inference were all above 70 (range = 0-100). The highest of the scores was recorded for the analysis construct. These results are encouraging, because they indicate that students scored above average on all critical thinking skills examined. Regardless, because of the non-random selection of participants, these findings cannot be applied to other situations.

Currently the Office of Institutional Assessment at Clemson University collects statistics for critical thinking ability of enrolled and recently graduated students. Most recently, 1350 students, representing all five colleges, took the Measures of Academic Proficiency and Progress (MAPP) exam by the Educational Testing Service (ETS). This exam seeks to measure students in 4 core skill areas: critical thinking, reading, writing and mathematics. In April 2008, 57% of students (chiefly seniors) were not proficient in critical thinking (n=685), the highest of all constructs (Figure 2.1). Only five months earlier, 70% of students (chiefly freshman) were not proficient in the critical thinking construct (n=675), also the highest non-proficient construct (Figure 2.1).
Seniors in 2008 scored between the 50th and 75th percentile nationally, while 2007 freshmen scored between the 75th and 90th percentile nationally. This shocking discovery warrants a deeper look into critical thinking ability and what can be done at Clemson University. Currently the MAPP scores, along with two other standardized exams Clemson has piloted, are used for the Voluntary System of Accountability (VSA). The VSA website assists prospective students in making direct comparisons of schools utilizing testing scores. Further, core competency scores (MAPP) assist is the re-accreditation process by the Southern Association of Colleges and Schools (SACS).

Evaluation Courses

Evaluation courses at Clemson University include Principles of Equine Evaluation, Livestock Selection and Evaluation and Dairy Cattle Selection. These courses are thought to increase critical thinking ability and enhance independent decision making by past participants (Kauffman, et al. 1971). However to our knowledge, no research studies have confirmed or discouraged this generalization. In relation to the
higher orders of Bloom’s Taxonomy (Bloom et al., 1956), evaluation classes involve a significant quantity of critical thinking; including application of criteria for evaluating animals, analysis of individual classes, synthesis of criteria, and evaluation of multiple species and disciplines. The main objectives behind an evaluation class typically include learning and demonstrating knowledge of general judging criteria, distinguishing level of performance based on criteria, the ability to critically and independently evaluate classes, and developing written and oral justification for judgments. These are all action terms for higher order thinking, which encompass the four higher levels of Bloom’s Taxonomy, application, analysis, synthesis, and evaluation (Bloom et al., 1956).

Little research has looked specifically at the relationship of evaluation courses and their ability to foster critical thinking processes. Logically, it makes sense that a course utilizing higher order thinking would produce a student better equipped to handle critical thinking. Researchers in Missouri (Shann et al., 2006) examined the critical thinking ability of undergraduate students (n=63) enrolled in a Live Animal and Meat Evaluation course using the WGCTA. Students were given either form A or form B on the first class day (pre-test) and again on the last class day (post-test); students that received form A initially received form B for the post-test, and vice versa. Course work included sixteen weeks of instruction in animal anatomy; live animal evaluation and pricing; carcass grading; carcass pricing; and ranking philosophies for beef, pork, and lamb. Students significantly improved their final WGCTA score from the first to the last class day (39.9 and 55.5, respectively).
Conclusions

A broad range of mind-sets exist toward evaluation courses as a vital part of a college of agriculture curriculum. Research is needed in the area to resolve these different viewpoints. Understanding how different courses and coursework affect a student’s ability to think critically is a worthwhile goal. Aside from more efficient teaching practices, frustration and annoyance that discourages students and teachers alike can be avoided. Producing a well rounded student capable of higher order thinking, who can be instrumental in the work force is not only a worthy goal, but an achievable one.
CHAPTER THREE

LEVEL OF ACADEMIC CHALLENGES PROVIDED TO STUDENTS IN SELECTED CLASSROOMS IN THE COLLEGE OF AGRICULTURE

Abstract

Higher education is charged with preparing individuals who are capable of successfully navigating the real-world. This goal begins in the classroom. It is imperative that college of agriculture graduates possess a balanced combination of base knowledge and independent thought combined with critical thinking ability. Development of critical thinking skills aids in student retention and understanding of fundamental information that is presented in lecture format (Spady, 1994). While these elements are essential, some students do not acquire them to the fullest extent possible. Torres and Cano (1995) found that senior students enrolled in a college of agriculture program are graduating with less than adequate cognitive skills which are vital to solve problems, make decisions, and think critically. The focus of this project was to qualify the level of academic challenges provided to students in selected courses in the Animal and Veterinary Sciences department at Clemson University, including both evaluation (E) and non-evaluation (N) courses. E courses averaged 47.7% of all challenges at the highest level of cognition compared to N courses which averaged only 25% at the highest level of cognition. Producing a well-rounded student capable of independent thought, decision making, and critical thinking ability at higher levels of cognition is a worthwhile goal for all institutions of higher learning.
Introduction

Challenges faced by American colleges and universities are numerous, including preparing individuals capable of higher order thinking. Higher order thinking stipulates that a person is proficient at making independent decisions and thinking critically. Producing a person capable of these essentials is no easy task and has been the topic of much discussion and deliberation. University and college professors must challenge students to perform at higher levels of cognition. Peters et al. (2002) state that students must be able to apply and integrate previously learned discrete facts to support their viewpoints in order to develop critical thinking skills.

Research shows that the majority of discourse and challenges provided by professors in a college of agriculture were at the knowledge and comprehension levels of Bloom’s Taxonomy, the lowest levels of cognition (Whittington & Newcomb, 1993; Ewing et al., 2006). Students should be taught to master the thinking and reasoning skills needed to utilize information at higher levels of cognition during instruction in the classroom (Meyers, 1988). Students should practice their higher order thinking skills through challenges that appeal to higher levels of cognition. In turn, students, their future employers, and society will be greatly benefited.

Cognitive Level of Academic Classrooms

If producing a well rounded student capable of higher order thinking is an end goal for higher education, then this goal begins in the classroom. Students must be taught at all levels of cognition to increase understanding and retention.
Whittington and Newcomb (1993) observed ten professors in a college of agriculture who taught freshman through senior level courses. Professors were surveyed before the start of the fall semester to determine their aspired goals for teaching at different levels of cognition. Aspired goals for discourse and testing were 71% and 74%, respectively, at the two lower levels of Bloom’s Taxonomy. Courses and assignments were evaluated throughout the semester and assessed for level of cognition. Researchers detected that 95% of discourse and 80% of testing challenged the students at the lowest levels of Bloom’s Taxonomy (Whittington and Newcomb, 1993). Professors participating in Whittington and Newcomb’s (1993) study failed to reach their aspired cognitive level for discourse and testing by as much as 30%.

Whittington (1995) utilized Newcomb-Trefz’s (1987) adjusted model of Bloom’s Taxonomy (1956) that corresponds Bloom’s knowledge, comprehension, application, analysis, synthesis and evaluation to remembering, processing, creating, and evaluating. Using these categories, participants were evaluated to determine the level they aspire to teach to, level of cognition instructors are actually teaching, attitudes toward teaching at higher levels of cognition, and relationships between the above objectives. Researchers recorded that instructors aspired to contribute 30% of teaching time at the remembering level and 24% at the processing level. The creating and evaluating levels ranged from 0 to 50% and 0 to 60%, respectively. Participants also indicated positive attitudes for teaching at higher cognitive levels. Observed cognitive level of instruction was as follows: 43% remembering, 55% processing, 1.5% creating (range 0 to 6%) and > 1%
evaluating. This major discrepancy for aspired and actual cognitive level of teaching is alarming and unfortunately, common.

Researchers in Ohio observed nine classrooms in a college of agriculture over a quarter and found that professors offered a mean of 5.8 challenges to students, with a mean of 2.7 different types of challenges (Ewing et al., 2006). This shows that professors offered multiple challenges to students of the same type. Similarly, researchers in Pennsylvania (McCormick and Whittington, 2000) utilized Bloom’s Taxonomy and observed a mean of 13.2 academic challenges provided to students with a mean of 4.6 different types of challenges. McCormick and Whittington observed faculty members (n=11) from nine departments in the College of Agricultural Sciences to describe types and frequency of academic challenges provided to students, determine the cognitive level of each academic challenge, and assess the value of each challenge to final grade. Levels observed for different challenges were 10.7 % at the knowledge level, 17.7 % at comprehension, 22.3 % at application, 15.8 % at analysis, 16.7 % at synthesis, and 16.4 % at the evaluation level. Researchers determined that, overall, 28.4 % of challenges were issued at the lower levels of cognition (knowledge and comprehension) and 71.6 % were issued to students at higher levels of cognition (analysis, application, synthesis, and evaluation). Finally, researchers looked at tabulation of final course grade. Higher and lower levels of cognition contributed equally to students’ final grade (50.4 % and 49.6 %, respectively). It seems unbalanced that 71.6 % of course work would be presented at higher levels of cognition (a common goal of educators), but representing only 50.4 % of the students’ final grade.
Education needs to inspire higher levels of cognitive thought to prepare students to be better equipped to face a challenging society. Logically, teaching and challenges should prepare students for the task and grading schemes in classrooms should reflect the amount of emphasis placed on higher order thinking. Whittington and Newcomb (1993) challenge American professors to test less at the remembering, or lowest level of cognition, and model higher order thinking during discourse for students.

**Cognitive Abilities of Students**

Current cognitive abilities of students must be understood so that improvements can be made. Torres and Cano (1995) tested senior students (n=196) enrolled in a college of agriculture using the DCAT, which examines three cognition levels that are congruent with the five lowest levels of Bloom’s Taxonomy (does not include evaluation). Researchers observed higher scores for the basic Cognitive abilities section and the Application abilities section when compared to the Critical Thinking abilities section (19.8 and 20.1 vs. 16.8, respectively) (Torres and Cano, 1995).

Researchers in Florida (Ricketts and Rudd, 2005) used a researcher developed critical thinking skills test for selected youth leaders (n=207) in the National FFA Organization. The test examined three critical thinking skills identified by a panel of experts: analysis, evaluation, and inference. Mean scores for analysis, evaluation, and inference were all above 70 (range = 0-100). The highest of the scores was recorded for the analysis construct. These results are encouraging, because they indicate that students scored above average on all critical thinking skills examined. Because of the non-random selection of participants, these findings cannot necessarily be applied to other situations.
Friedel et al. (2006) attempted to determine whether overtly teaching for critical thinking would influence critical thinking skills of undergraduates (n=58) enrolled in two similar agri-science courses covering biotechnology concepts. In one course, the instruction method centered on overtly teaching for critical thinking, the second course served as the control, where normal lecture discourse was applied. To overtly teach for critical thinking, students were taught components of critical thinking and then asked to utilize learned skills during class. There was a larger (P=0.03) increase (pre-test = 187.55 vs. post-test = 196.15) for the course that utilized overt teaching concepts compared to the course that utilized lecture-style teaching methods (pre-test = 171.50 vs. post-test = 171.83) (Friedel et al., 2006). This is a positive finding for teachers, as students can gain necessary critical thinking skills when taught a simple outline of critical thought processes.

**Evaluation Courses**

Evaluation courses studied at Clemson University include *Principles of Equine Evaluation* and *Livestock Selection*. Evaluation courses teach students to evaluate animals against a breed ideal using conformation or performance criteria. Animals are typically evaluated in sets of 4, and are placed in order of best fit to breed ideals. Students are taught basic information initially, and then through practice judging of multiple classes, students add more detail to their base knowledge. On any given class day students practice placing 1 to 5+ classes of animals. This requires the student to remember material previously learned and apply it to a group of animals never before seen, critically analyze them, and deliver a quality judgment. Students are graded on
their assessment, so quality judgments are crucial. Students are also required to develop oral justification (reasons) of their placing of animals and give their reasons in an individual oral presentation format. Reasons are also graded; therefore, students must accurately relate known material to the class, and then describe the relevance appropriately.

Evaluation courses are thought to increase critical thinking ability and enhance independent decision making. No research studies, however, have confirmed or discredited this generalization. In relation to the higher orders of Bloom’s Taxonomy (Bloom et al., 1956), evaluation classes involve a significant quantity of critical thinking; including application of criteria for evaluating animals, analysis of individual classes, synthesis of criteria, and evaluation of multiple species and disciplines. The main objectives behind an evaluation class typically include learning and demonstrating knowledge of general judging criteria, distinguishing level of performance based on criteria, the ability to critically and independently evaluate classes, and developing written and oral justification for judgments. These are all action terms for the four higher levels of Bloom’s Taxonomy (Bloom et al., 1956).

Little research has been conducted specifically on the relationship between evaluation courses and their ability to foster critical thinking processes. It makes sense that a course utilizing higher order thinking would produce a student better equipped to handle critical thinking. Researchers in Missouri (Shann et al., 2006) examined critical thinking ability using the WGCTA of undergraduate students (n=63) enrolled in a live animal and meat evaluation course. Students were given either form A or form B on the
first class day (pre-test) and again on the last class day (post-test); students that received form A initially received form B for the post-test, and vice versa. Course work included sixteen weeks of instruction in animal anatomy, live animal evaluation and pricing, carcass grading, carcass pricing, and ranking philosophies for beef, pork, and lamb. Students significantly improved their final WGCTA score from the first to the last class day (39.9 and 55.5, respectively).

Methods

This objective of the study was exploratory and descriptive in nature. Instructors and professors participating in this study were full time faculty with 20% or greater teaching appointments in the Animal and Veterinary Sciences department at Clemson University. Participants elected to be involved in the study and therefore may or may not be a representative sample of the entire population of faculty in the department or college.

Population

The target population encompassed 55 courses taught in the Animal and Veterinary Sciences Department (AVS) at Clemson University. The Animal and Veterinary Sciences Department offers three undergraduate academic concentrations, including Animal Agribusiness, Equine Business, and Pre-veterinary and Science. A sample population of upper (300 – 400) level courses (n=10) from across the emphasis categories in the Department of Animal and Veterinary Sciences was chosen. Courses were grouped into two categories, (E) evaluation (n=2) or (N) non evaluation (n=8). Upper level courses were chosen because they would ideally incorporate learned material
from lower level courses into challenges presented to the students. Higher level courses would preferably appeal to the student’s higher order thinking as, purportedly, students would have to build upon base knowledge, using previously learned elements, coupled with new concepts to form a fresh conclusion. Therefore, these courses are thought to most likely possess higher order instruction.

Procedure

A group of undergraduate research assistants was formed to complete this study. Seven undergraduate students from the department of Animal and Veterinary Sciences at Clemson University participated as research assistants. Research assistants (RA) met with me for several hours two times per week throughout the semester for training in research techniques initially, then for evaluation of courses toward the end of the semester (Appendix B-2). During the research sessions, RA’s were trained to evaluate discourse in practice sessions where possible class scenarios were enacted. RA’s were required to evaluate sample discourse independently, then results from each of their evaluations were gone over one at a time, so everyone could learn from any mistakes made.

All participating instructors provided access to their classroom randomly throughout the semester (without their prior knowledge on any given day) to allow RA’s to gather data on the cognitive level of teaching practices and activities presented in class. Two RA’s independently evaluated discourse for each course twice throughout the semester, and results of evaluations were averaged. RA’s were required to record all events in class broken down in 10-minute intervals. RA’s were also required to record all
questions and challenges given to the class by the instructor. Descriptions of class activities were analyzed later by the entire group of RA’s and me for cognitive level of instruction. Analysis of cognitive level of instruction by me and the RA’s happened independently; then results were averaged.

Instructors also provided a copy of the course syllabus; copies of all materials used in and outside of class; and disclosed information when questions arose regarding academic challenges in their classroom. Academic challenges were categorized as to type for each course. The categories observed included in-class activities; quizzes; exams; midterm exams; final exams; laboratory quizzes, exams, and finals; projects (team and individual); presentations; and written reports. Frequency of each type of challenge for individual courses was also recorded.

For each challenge, a self-designed record (Appendix B-3) sheet was employed to assess level of cognition required for students to complete each task fully, utilizing key word from Bloom’s Taxonomy (Bloom et al., 1956). Individual questions were analyzed; each question could have multiple parts that were broken up into different levels of cognition if appropriate. Action words identified with assistance from Bloom et al. (1956) and McCormick and Whittington (2000) were utilized to assist in classifying challenges appropriately (Table 1). We analyzed each question or part of a question, determined the cognitive level of thought required to answer the question, and recorded a hash mark in the appropriate place on the record sheet corresponding with the appropriate level of cognition. All researchers scored each challenge separately. Hash marks were totaled for each challenge, and then percentages were calculated for the different levels of
cognition required to complete the challenge. For example, a quiz with only one question, where both parts are weighted equally would be as follows: Name the organs of the horse’s GI tract, in order, from esophagus to anus; then compare and contrast digestion in the foregut vs. the hindgut. This question appeals to the knowledge and evaluation levels of a student’s cognitive domain - knowledge to complete the first half of the question, because the student must remember material previously learned; and evaluation to complete the second half of the question, because the student must evaluate and compare processes previously learned. If each section of the question was equally weighted for grading purposes, then the result would be that 50% of this challenge was at the lowest levels of cognition, and 50% of the challenge was at the highest levels of cognition.

Each course was evaluated to determine the impact of the different challenges on the student’s final course grade using the grading scheme outlined in the syllabus for each course. The cognition percentage for each challenge was calculated to determine the total cognitive impact on the final course grade. The cognitive level of instruction and challenges were compared to cognitive level of final course grade determination.

Comparisons were made between evaluation and non-evaluation courses for all aforementioned attributes.

Instrumentation

Bloom’s Taxonomy outlines a classification of education outcomes, which divides cognitive domain into six categorical levels. The organization of these major classes of cognitive domain represents a hierarchical order such that the objectives in one
class are likely to make use of and be built on the behaviors found in the previous classes (Bloom et al., 1956). Bloom’s organization of cognitive domain begins with the most basic and follows a hierarchy to the most difficult. The two lowest levels of Bloom’s Taxonomy are considered the lowest level of cognition 1) Knowledge, 2) Comprehension, and the four highest levels of cognition are considered higher order thinking, or the highest levels of cognition 3) Application, 4) Analysis, 5) Synthesis, 6) Evaluation. Key words that appeal to each of the six levels of Bloom’s Taxonomy are recorded in Figure 3.1.

**Figure 3.1. List of indicators for Bloom’s Taxonomy of cognitive development.**

<table>
<thead>
<tr>
<th>Knowledge (Low)</th>
<th>assign, select, choose, list, define, label, match, describe, designate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension (Low)</td>
<td>explain, paraphrase, summarize, rewrite, revise, correct, give examples, clarify, modify, amend, illustrate</td>
</tr>
<tr>
<td>Application (High)</td>
<td>compute, demonstrate, use, predict, discover, solve, apply, adapt, validate, prove, establish, reveal, calculate</td>
</tr>
<tr>
<td>Analysis (High)</td>
<td>consider, differentiate, discriminate, relate, diagram, distinguish, reflect, take into account, with respect to</td>
</tr>
<tr>
<td>Synthesis (High)</td>
<td>create, compose, produce, develop, generate, build, invent, design, initiate, construct</td>
</tr>
<tr>
<td>Evaluation (High)</td>
<td>justify, compare and/or contrast two or more things, evaluate, interpret, classify, validate, defend, rationalize, give reason or explanation for, substantiate</td>
</tr>
</tbody>
</table>

*adapted from Bloom’s Taxonomy (1956)*
Data analysis

All data were analyzed for type and frequency of challenges and total and average number of challenges presented across evaluation (E) and non-evaluation (N) courses. Cognitive level of discourse and challenges were assessed. Each course was evaluated to determine impact of the different challenges on the student’s final course grade, and the role the level of cognition played in determining that grade. The cognitive level (high or low) of in-class activities and instruction was also compared to cognitive level of testing and final course grade and described. Finally, differences between E and N courses with regard to level of academic challenges, discourse, and final course grade calculation were described.

Results

The ten courses studied in the department of Animal and Veterinary Sciences averaged 13.9 challenges presented to students throughout the semester. The largest number of challenges presented by an evaluation course was 26, compared to a non-evaluation course at 21. The fewest number of challenges presented to students was in a non-evaluation course at 4 total challenges (Table 3.1). There were 12 total different types of challenges presented to students in the ten Animal and Veterinary Science courses studied. Two courses utilized six different types throughout the semester while two courses only used one type of challenge.
Table 3.1. Animal and Veterinary Sciences courses and list of challenges.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Courses</th>
<th>E1</th>
<th>E2</th>
<th>N1</th>
<th>N2</th>
<th>N3</th>
<th>N4</th>
<th>N5</th>
<th>N6</th>
<th>N7</th>
<th>N8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments in class</td>
<td></td>
<td>26</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Quizzes</td>
<td></td>
<td>6</td>
<td>18</td>
<td>10</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Exams</td>
<td></td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Final Exam</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lab Quizzes</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lab Exam</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Laboratory Final</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>Team Project</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ind. Project Presentation</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Written Report</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Total Challenges</td>
<td></td>
<td>26</td>
<td>24</td>
<td>5</td>
<td>21</td>
<td>6</td>
<td>14</td>
<td>7</td>
<td>4</td>
<td>21</td>
<td>11</td>
</tr>
</tbody>
</table>

Evaluation (E) courses averaged 52.3% of all challenges presented at the lowest levels of cognition compared to N courses averaging 75% at the lowest levels.

More in-class assignments were observed and/or graded in evaluation courses when compared to non-evaluation courses (41 to 1, respectively). The in-class assignments for the evaluation course were typically placing classes and giving reasons, which require the student to interpret, analyze, evaluate, and defend judgments, all higher levels of Bloom’s Taxonomy (1956). The evaluation courses averaged 80% of instruction observed at the highest levels of cognition, while the non-evaluation averaged 15.8% of instruction at the highest levels of cognition. All challenges presented in E courses averaged 71% at the highest levels of cognition and the N courses challenged the students at the highest levels of cognition only 25% of the time.
Evaluation and non-evaluation courses were dissimilar when comparing level of
cognition of instruction, all challenges, and the cognitive level of the final course grade.
Both groups of courses followed a similar pattern for cognitive level of instruction and
calculation of final course grade. For all instruction and challenges presented in
evaluation courses, 24.5% were at the two lower levels of cognition, while 32.1% of the
final course grade was decided on lower levels of cognition challenges. Non-evaluation
courses averaged 78.1% of instruction and challenges at the lowest levels of cognition,
with 73.8% of the final course grade coming from the lower levels of cognition. A record
of cognition level for all courses studied is presented in Table 3.2.
Table 3.2. Percentage of cognitive level of instruction, challenges, and final course grade of Animal and Veterinary Sciences courses.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Cog. Level</th>
<th>Teaching</th>
<th>Challenges</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 1</td>
<td>L</td>
<td>26</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>74</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>E 2</td>
<td>L</td>
<td>14</td>
<td>58</td>
<td>54.2</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>86</td>
<td>42</td>
<td>45.8</td>
</tr>
<tr>
<td>N 1</td>
<td>L</td>
<td>100</td>
<td>98.4</td>
<td>98.4</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>0</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>N 2</td>
<td>L</td>
<td>84.3</td>
<td>87.9</td>
<td>73.7</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>15.7</td>
<td>12.1</td>
<td>26.3</td>
</tr>
<tr>
<td>N 3</td>
<td>L</td>
<td>78</td>
<td>36.7</td>
<td>38.8</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>22</td>
<td>63.3</td>
<td>61.2</td>
</tr>
<tr>
<td>N 4</td>
<td>L</td>
<td>87</td>
<td>94.6</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>13</td>
<td>5.4</td>
<td>15</td>
</tr>
<tr>
<td>N 5</td>
<td>L</td>
<td>72</td>
<td>73.7</td>
<td>74.2</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>28</td>
<td>26.3</td>
<td>25.8</td>
</tr>
<tr>
<td>N 6</td>
<td>L</td>
<td>82</td>
<td>34.9</td>
<td>34.9</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>18</td>
<td>65.1</td>
<td>65.1</td>
</tr>
<tr>
<td>N 7</td>
<td>L</td>
<td>84.6</td>
<td>98</td>
<td>98.2</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>15.4</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>N 8</td>
<td>L</td>
<td>86</td>
<td>90.4</td>
<td>87.3</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>14</td>
<td>9.6</td>
<td>12.7</td>
</tr>
</tbody>
</table>

Courses: E indicates evaluation courses; N indicates a non-evaluation course.
Cognition level:
L indicates lowest levels of Bloom’s Taxonomy: knowledge, comprehension
H indicates highest levels of Bloom’s Taxonomy: application, analysis, synthesis, evaluation

**Discussion and Conclusions**

Evaluation courses utilized higher order levels of cognition than non-evaluation courses in instruction, challenges, and contribution to final course grade. Evaluation courses incorporated the highest percentages of higher order thinking during instruction compared to both cognitive level of final course grade, and challenges (80%, 71%, and 67.9%, respectively). This agrees with research and popular cognitive theory, which explains that to ensure the success of students, instructors must facilitate learning and thinking at high cognitive levels in the classroom, not simply be transmitters of
information (Gokhale, 1995; Schillo, 1997; & Kail & Cavanaugh, 2007). Logically this would be to the student’s advantage, to learn to think at higher levels of cognition from demonstrations in the classroom, as opposed to being challenged and tested at higher levels without first learning to think at high levels of cognition in the classroom.

Students were then given many opportunities to develop higher order thinking skill through multiple challenges at the highest levels of cognition.

Non-evaluation course data showed that cognitive levels of teaching did not match cognitive level of challenges. Instruction in N courses averaged 15.8% at the highest levels, while challenges averaged 25% at the highest levels of cognition. These findings agree with previous research that found instruction and challenges presented primarily (over 60%) at the lowest levels of cognition (Whittington & Newcomb, 1993; Whittington, 1995; Ewing et al., 2006). Students’ final course grades averaged 26.2% from the highest levels of cognition. This seems disproportionate; can students be expected to do well on higher order thinking challenges if higher order thinking has not been demonstrated for them in the classroom? Further, students are expected to earn their final grade utilizing more higher order thinking than was modeled for them in the classroom, or than they had the opportunity to practice when completing challenges.

Instructors should be aware of the role they play in developing a student’s mind to operate at the highest levels of cognition. Instructors can determine the level of cognition that is appropriate for the courses they teach, and plan lessons and challenges that will facilitate learning and thinking. It is important that discourse and challenges are fair and reasonable; it should not be assumed that a student could complete all challenges using
higher order thinking if they have not first received some level of training in the classroom. How the student is to be evaluated throughout the semester and earning their final grade, must be considered early and be well thought out by the instructor. Once the instructor is aware of the significance of their grading decisions, action can be taken to encourage all levels of thought, including higher order thinking, in an appropriate manner so students are not overwhelmed. Educators must take care to develop students in all areas of higher order thinking and create an environment that facilitates higher levels of cognitive development over time.
CHAPTER FOUR

COMPARATIVE DEVELOPMENT OF CRITICAL THINKING SKILLS IN ANIMAL SCIENCE UNDERGRADUATES WHO ENROLL IN EVALUATION COURSES

Abstract

Animal evaluation courses have been part of animal science curricula for over 90 years at colleges and universities across the country. A need for teaching generally accepted criteria for evaluating livestock, industry standards, and rules to compare multiple animals laid the foundation for evaluation courses. Attributes of evaluation courses are believed to contribute to higher order thinking. Therefore, this study sought to quantify the change in critical thinking ability of students enrolled in an evaluation course. The Watson-Glaser Critical Thinking Appraisal (WGCTA) exam provided means to objectively analyze critical thinking ability by examining five constructs: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. The sample population consisted of students enrolled in evaluation courses (E) and a non-evaluation course (N) at Clemson University, Equine Evaluation (n=15), Livestock Evaluation (n=19), and Animal Reproduction (n=44). Students were issued the WGCTA during the first week (pre-test) and last week (post-test) of class. E and N courses scored similarly on the pre-test (57 and 57.5, respectively), but the E courses scored higher (P=0.005) than N on the post-test (59 and 53, respectively). The mean change in scores from pre-test to post-test for the N and the E group were -3.0 and 2.0, respectively (P=0.001). Students enrolled in an evaluation course increased their critical thinking ability score from pre to post test, whereas students in the non evaluation group showed a decrease over the same period.
**Introduction**

Evaluation courses have remained an integral part of animal science programs throughout the country; however, they are under scrutiny as their usefulness is not well documented and they are deemed by some faculty to be obsolete and un-scientific. An evaluation course focuses on teaching students generally accepted criteria for evaluating particular animals against breed standards and then requires the student to evaluate and rank multiple animals, making an independent and justified decision. A student who becomes very skilled at evaluation can integrate those decision making skills into real-world situations, including employment. Attributes of evaluation courses are believed to contribute to higher order thinking and specifically critical thinking. Judging teams and evaluation courses have been associated with developing increased ability to communicate, solve problems and make decisions (Boyd et al., 1992; Rusk et al., 2002).

Development of critical thinking skills aids in student retention and in understanding of fundamental information that is presented in lecture format (Spady, 1994). It is imperative that college of agriculture graduates possess a balanced combination of base knowledge and independent thought combined with critical thinking ability. While these elements are essential, some students do not acquire them to the fullest extent. Previous research shows that senior students in a college of agriculture scored lowest on a critical thinking ability construct in comparison to basic cognitive ability and applications ability (Torres and Cano, 1995). One of the objectives of this study was to quantify the improvement or regression (change) in critical thinking ability of students enrolled in an evaluation course, compared to students not enrolled in an
evaluation course. Evaluation courses at Clemson University include *Principles of Equine Evaluation, Livestock Selection and Evaluation* and *Dairy Cattle Selection.* These courses are thought to increase critical thinking ability and enhance independent decision making. However, to our knowledge, no studies have confirmed or refuted this generalization.

**Critical Thinking**

A definition of critical thinking is elusive. Critical thinking has long been defined in a narrow frame of reference such as a form of logic, or a watered down version of the scientific method (Meyers, 1988). Many researchers use the term synonymously with higher order thinking (Cano, 1993, Whittington and Newcomb, 1993, Whittington 1995, McCormick and Whittington, 2000). Others dispute this claim and argue that critical thinking is the ability of a person to take charge of their own thinking (Ricketts 2003). Still others believe it is the ability to formulate generalizations, entertain new possibilities, and suspend judgment (Meyers, 1988). It seems a more appropriate definition would expand critical thinking to include a variety of personal perspectives and subjective focuses. Certainly, understanding critical thinking is paramount to evaluation of critical thinking. The Watson-Glaser Critical Thinking Appraisal (WGCTA) exam evaluates critical thinking ability through constructs, including inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. These subsets are synonymous with higher order thinking defined by Bloom’s Taxonomy (Bloom et al., 1956). The identification of these subsets for the evaluation of critical thinking suggests that the definition for critical thinking is not far from that of higher order thinking.
Evaluation Courses

Researchers in Missouri (Shann et al., 2006) examined the critical thinking ability of undergraduate students (n=63) enrolled in a live animal and meat evaluation course using the WGCTA. Students were given one of two tests (form A or form B) on the first class day (pre-test) and again on the last class day (post-test); students who received form A initially received form B for the post-test, and vice versa, to exclude any confounding effects by taking the same test twice. Course work included sixteen weeks of instruction in animal anatomy, live animal evaluation and pricing, carcass grading, carcass pricing, and ranking philosophies for beef, pork, and lamb. Students significantly improved their final WGCTA score from the first to the last class day (39.9 and 55.5, respectively).

Little research has examined the relationship of evaluation courses and their ability to foster critical thinking processes. It makes sense that a course utilizing higher order thinking would produce a student better equipped to handle critical thinking. In relation to the higher orders of Bloom’s Taxonomy (Bloom et al., 1956), evaluation classes involve a significant amount of critical thinking; including application of criteria for evaluating animals, analysis of individual classes, synthesis of criteria, and evaluation of multiple species and disciplines. The main objectives behind an evaluation class typically include students learning and demonstrating knowledge of general judging criteria, distinguishing level of performance based on criteria, evaluating classes critically and independently, and developing written and oral justification for judgments. These are all action terms for the four higher levels of Bloom’s Taxonomy and indicate that
simply through participation in class, students can practice thinking at the highest levels
of cognition (Bloom et al., 1956).

**Methods**

This study sought to determine the effect of evaluation courses on critical thinking
ability over the course of a semester compared to a non-evaluation course measured by
critical thinking scores on a standardized critical thinking test (WGCTA). The
methodology was approved by the Institutional Review Board (IRB) at Clemson
University.

The null hypothesis stated that the change in critical thinking scores of students
enrolled in evaluation courses is not different than the change in score over a semester for
students enrolled in a non-evaluation course. The alternative hypothesis stated that there
is a difference in change in critical thinking score over a semester for evaluation courses
and non-evaluation courses.

The experimental design is:

```
O1  X  O2
---
O3  O4
```

O₁ represents the students enrolled in evaluation courses and O₃ represents students
enrolled in the non-evaluation course at the beginning of the semester. O₂ and O₄
represent the respective groups of students at the end of the semester, after X, the
treatment, exposure to instruction received in an evaluation course which occurred over
the course of a semester.
Population

The target population was students enrolled in the Animal and Veterinary Science curriculum at Clemson University. The sample population consisted of students enrolled in Equine Evaluation (n=15), Livestock Evaluation (n=19), and Animal Reproduction (n=44) within the department of Animal and Veterinary Sciences at Clemson University.

Animal Reproduction was selected as the control course because it is a common course taught in animal science departments across the country, mainly mid- to upper-class students should be enrolled in the course, and historically it has maintained a high enrollment number.

Instrumentation

The Watson-Glaser Critical Thinking Appraisal (WGCTA) test, forms A and B, from Harcourt Assessment, was used to objectively assess students’ critical thinking ability. Students were issued the WGCTA exam during the first week (pre-test) and last week (post-test) of class. Students received regular instruction from the assigned professor for each course throughout the semester.

Data Analysis

The data were coded and analyzed using Microsoft Office Excel. Descriptive and inferential statistics were used to analyze the data. Descriptive statistics included means, averages, and percentages. Inferential statistics utilized included a t-test. All data were analyzed to determine the change in score from the pre-test to the post-test for each participant and then groups were averaged. A t-test was conducted to determine whether a difference exists between the changes in score for each of the evaluation courses, then
(E) evaluation courses were combined and compared to the (N) non-evaluation course to determine change in critical thinking score over the semester for each type of course.

**Results**

Students in the non-evaluation course (n=44) averaged 57.5 on the pre-test and 54.5 on the post-test. The students enrolled in the evaluation courses (n=34) averaged 57 on the pre-test and 59 on the post-test. Both groups scored similar on the pre-test (P=0.39). The evaluation group scored higher on the post-test than the non-evaluation group (P=0.005). Average change in score for the evaluation courses only (livestock and equine) were 1.68 and 2.93, respectively. A t-test determined the change in score over the course of the semester for the evaluation courses was not different (P=0.54), so results from both could be accurately combined. The mean change in score from pre-test to post-test for the non-evaluation and the evaluation courses were -3.0 and 2.0, respectively (P=0.0001). Raw scores and t-test results are reported in Table 4.1 and 4.2. Students in the evaluation courses scored higher on the inference, deduction, and evaluation of arguments sections of the WGCTA post-test (P=0.01, 0.06, 0.04, respectively) (Table 4.2).

Table 4.1. Average pre test scores for WGCTA constructs of (N) non evaluation and (E) evaluation courses.

<table>
<thead>
<tr>
<th>WGCTA constructs</th>
<th>N</th>
<th>E</th>
<th>P</th>
</tr>
</thead>
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<tr>
<td>Inference</td>
<td>9.5</td>
<td>9</td>
<td>0.24</td>
</tr>
<tr>
<td>Recognition of Assumptions</td>
<td>12</td>
<td>12</td>
<td>0.47</td>
</tr>
<tr>
<td>Deduction</td>
<td>11</td>
<td>11</td>
<td>0.47</td>
</tr>
<tr>
<td>Interpretation</td>
<td>13</td>
<td>12</td>
<td>0.18</td>
</tr>
<tr>
<td>Evaluation of Arguments</td>
<td>12</td>
<td>13</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>57.5</td>
<td>57</td>
<td>0.39</td>
</tr>
</tbody>
</table>
Table 4.2. Average post test scores for WGCTA constructs of (N) non evaluation and (E) evaluation courses.

<table>
<thead>
<tr>
<th>WGCTA constructs</th>
<th>N</th>
<th>E</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inference</td>
<td>8.5</td>
<td>10</td>
<td>0.01</td>
</tr>
<tr>
<td>Recognition of Assumptions</td>
<td>12</td>
<td>12</td>
<td>0.21</td>
</tr>
<tr>
<td>Deduction</td>
<td>11</td>
<td>12</td>
<td>0.06</td>
</tr>
<tr>
<td>Interpretation</td>
<td>11</td>
<td>13</td>
<td>0.04</td>
</tr>
<tr>
<td>Evaluation of Arguments</td>
<td>12</td>
<td>12</td>
<td>0.27</td>
</tr>
<tr>
<td>Total</td>
<td>54.5</td>
<td>59</td>
<td>.005</td>
</tr>
</tbody>
</table>

Discussion and Conclusions

The WGCTA is an effective and widely recognized tool for evaluating student critical thinking ability (Watson & Glaser, 1980). In this study, students enrolled in the evaluation courses increased their critical thinking ability compared to those enrolled in a non evaluation course. Students enrolled in either E or N courses were similar (P=0.39) scoring on the pre-test taken at the beginning of the semester (57 and 57.5, respectively). After the course of a semester, and the E courses received animal evaluation training, the E courses scored higher (P=0.005) than the N course on the post-test (59 and 54.5, respectively). Students in an evaluation course exhibited greater change in critical thinking score pre-test to post-test than students enrolled in a non evaluation course (P=0.0001). The evaluation courses utilized independent judgments and justifications for judgments which are thought to enhance intellectual development and higher order thinking (Schillo, 1997). Instructors in an evaluation course relate knowledge to an applicable need, and demonstrate principles that have been initially described verbally, which is consistent with previous research that agrees these activities motivate students to
learn and think at higher levels of cognition (Kauffman et al., 1971; Taylor & Kauffman, 1983; Schillo, 1997).

There was a low change in score for the semester in both types of courses (E = 2, N = -3). A possible reason for the low change in score was the timing of the post-test. Students in both groups took the post-test during the final week of classes on consecutive days. In some cases this was the class’s very last meeting, a day when some students were taking final exams. Students could have been preoccupied with exams, graduation, summer break, etc. Even though the change in score was low for both groups, we expect that the outside of class factors that might have contributed to the low change (or drop in score for the N course) to have happened equally for both the N and E groups. Therefore the corresponding difference in critical thinking change in score for both groups is expected to be equally affected and the difference between the two groups is still considered valid.

A broad range of mind-sets exists toward evaluation courses as a vital part of a college of agriculture curriculum. More research is needed in the area to solidify these different viewpoints. Specifically, understanding how different courses and coursework affect a student’s ability to think critically is a worthwhile goal. Evaluation courses involve a significant amount of hands-on work, allowing the student to continuously utilize skills taught in class, and develop lasting decision making skills (Rusk et al., 2002). Because the students are graded on their assessment and justification while utilizing appropriate industry standards, making quality independent decisions are stressed. Continuous immersion in higher order thinking opportunities could be a crucial
ingredient for development of critical thinking skills, and thus the reason for the greater change in critical thinking score observed in the evaluation class.

Dissecting out specific practices involved in an evaluation course that contribute to higher order thought process, and how each contribute, should be a direction of future research. Challenges that contribute to higher order thinking in evaluation courses could be manipulated and utilized in other courses to ensure undergraduates are submersed in higher order thinking opportunities across the major curriculum while they are in college. Aside from more efficient teaching practices, frustration and annoyance that discourages students and teachers alike can be avoided. Producing a well rounded student capable of higher order thinking that can be instrumental in the work force is not only a worthy goal, but an achievable one.
CHAPTER FIVE

DIFFERENCES WITHIN DEMOGRAPHIC CHARACTERISTICS OF ANIMAL SCIENCE UNDERGRADUATES RELATING TO CRITICAL THINKING ABILITY.

Abstract

Critical thinking and independent decision-making are essential for graduates. Understanding descriptive and demographic information that may contribute to critical thinking ability would be advantageous. Multiple demographic characteristics have been studied to identify their capability of describing critical thinking ability. The available data are variable to say the least and, in some cases, incomplete. Some possible factors include age, gender, GPA, learning style, and classification level in college. Therefore, the focus of this study was to quantify the critical thinking ability of students in selected classrooms in an animal science department and determine differences in demographic information (if any). The Watson-Glaser Critical Thinking Appraisal (WGCTA) test, form A and B, from Harcourt Assessment provided means to objectively assess students’ critical thinking ability. The WGCTA seeks to provide an estimate of an individual’s standing on a composite of attitude, knowledge, and skills by means of evaluating the student’s ability to think critically in five categories: 1) Inference; 2) Recognition of Assumptions; 3) Deduction; 4) Interpretation, and 5) Evaluation of Arguments. Categories are weighted equally and final score is on a 0-80 scale. Each student completed a questionnaire to determine demographic information with respect to age, gender, classification level in school, GPA, and previous judging experience. All data were analyzed for mean and standard deviation of final scores. Mean score was 58.4 ± 7.00 (n=83). Several demographic characteristics showed higher scores on the WGCTA;
students in the 18-20 age range (n=43), those who reported >3.4 GPA (n=25), and those who had experience judging or had at least 1 semester of evaluation training (n=25) scored higher than students who had no previous evaluation training (P=0.0009). Differences in classification and gender did not appear to show differences in a student’s critical thinking ability. Differences in age, GPA, and previous judging experience did show differences in students’ critical thinking ability.
Introduction

Challenges faced by American colleges and universities are numerous, including preparing an individual capable of higher order thinking. Characteristics indicative of a person who exhibits higher order thinking include quality independent thought and decision making skills (Bloom et al., 1956). Producing a person capable of these essentials is no easy task and has been the topic of much discussion and deliberation. Professors and instructors at today’s universities must challenge students to perform at higher levels of cognition in order to prepare them to function effectively in an increasingly complex and challenging world. Understanding critical thinking ability is the first step to graduating students with improved critical thinking skills.

A definition of critical thinking is elusive. Critical thinking has long been defined in a narrow frame of reference such as a form of logic, or a watered down version of the scientific method (Meyers, 1988). Many researchers use the term synonymously with higher order thinking (Cano, 1993, Whittington and Newcomb, 1993, Whittington 1995, McCormick and Whittington, 2000). Others dispute this claim and argue that critical thinking is the ability of a person to take charge of their own thinking (Ricketts 2003). Still others believe it is the ability to formulate generalizations, entertain new possibilities, and suspend judgment (Meyers, 1988). It seems a more appropriate definition would expand critical thinking to include a variety of personal perspectives and subjective focuses.

Understanding critical thinking is paramount to evaluation of critical thinking. The Watson-Glaser Critical Thinking Appraisal (WGCTA) exam evaluates critical
thinking ability through constructs, including inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. These subsets are synonymous with higher order thinking defined by Bloom’s Taxonomy (Bloom et al., 1956). The identification of these subsets for the evaluation of critical thinking suggests that the definition for critical thinking is not far from that of higher order thinking.

**Critical Thinking Skills**

The WGCTA evaluates students’ skills for Inference, Recognition of Assumptions, Deductions, Interpretation, and Evaluation of Arguments. Ricketts et al. (2005) and a panel of experts determined that the skills required for critical thinking were Interpretation, Analysis, Evaluation, Inference, Explanation, and Self-regulation. Interpretation and Recognition of Assumptions involve a clear understanding of experiences, beliefs, procedures, rules, etc. Analysis requires not only the understanding of multiple facets, but the relationships between ideas. Evaluation and Evaluation of Arguments require the student to assess the situation, compare it to known criteria, and determine its strength. Deduction is the ability to determine whether conclusions are logical based on known information. Inference is the ability to discriminate between varying degrees of truth of assumptions drawn from known information. Explanation is the ability to state and justify an outcome based on the above mentioned skills. Finally Self-regulation is the ability of students to ensure that they are engaging in critical thinking. Each of the skills mentioned is a building block for the next. A student cannot simply begin critical thinking for the first time at the Evaluation or even the Analysis.
element. The student must possess a strong base of knowledge to refer to when needed, which will facilitate critical thought processes.

**Demographic Descriptors of Critical Thinking Skills**

Multiple predictors have been studied to identify their influence on critical thinking abilities. Some possible factors include age, gender, GPA, and classification level in school. Being able to predict approximate critical thinking ability and generalize it across a certain student population is advantageous to better understanding the types of students in the population and the possible learning endeavors that would be most valuable. If differences between types of students exist, resources could be more focused to reach the largest number of students in the best way possible.

It would seem logical that as age increases, so would maturity and the ability to think at higher cognitive levels. Surprisingly, in the majority of studies, age shows no significant effects on critical thinking ability (Facione, 1990; Facione, 1991; Jenkins, 1998; Rudd et al., 2000; and Ricketts and Rudd, 2005). Cano (1993) found conflicting results regarding the influence of age on the cognitive level of performance associated specifically with critical thinking abilities. Cano studied the critical thinking ability of Ohio agricultural education high school students (n=384), using the Developing Cognitive Abilities Test (DCAT) and the Watson-Glaser Critical Thinking Appraisal (WGCTA) exams. Cano (1993) reported significant (P<0.03) differences between senior student scores (48.71) and freshman/sophomore students’ scores (43.81/47.45) on the DCAT. However, the WGCTA showed no effects of age on final scores using the same students. Previously, Cano and Martinez (1991) observed similar results of increased
cognitive score with regard to age/grade level using the DCAT to test high school agriculture education students (n=385).

If gender differences exist for ability to think critically, perhaps adjustments need to be made by secondary and post-secondary schools to facilitate learning. In regards to critical thinking ability, multiple studies observed no significant influences of gender on ability to think critically (Torres and Cano, 1995; Ricketts and Rudd 2005; Friedel et al., 2006). In contrast, a study by Wilson (1989) using the WGCTA exam observed gender as a significant indicator of critical thinking skill in college freshmen (n=203).

With regard to disposition or attitude toward thinking critically, Rudd et al. (2000) observed significant differences (P= 0.03) of mean score for females (n=110, avg. score = 297.8) and males (n=60, avg. score = 288.1) on the CCTDI which determines the extent to which the respondent is willing or desires to think critically. It is important to note that the CCTDI measures attitude and disposition of students that are likely contribute to higher order thinking, but not actual critical thinking ability. Other studies determined that gender was a useful variable to predict variance in attitude towards critical thinking ability (Walsh, 1996; Rudd et al., 2000).

It is reasonable to assume that students with a greater ability to think critically also perform better on standardized tests and have higher grade point averages (GPA). GPA has been a significant predictor of critical thinking skill in multiple studies; and in some cases, the only useful predictor (Giancarlo, 1996; Jenkins, 1998; and Thompson, 2001). GPA has been shown to be a factor in at least portions of critical thinking constructs on the CCTDI and researcher-developed critical thinking skills tests.
(Giancarlo & Facione, 2001; Ricketts & Rudd, 2005). Shann et al. (2006) examined undergraduate students (n=63) enrolled in a Live Animal and Meat Evaluation course at the University of Missouri-Columbia and determined that improvements made in the final scores of the WGCTA exam from the first class day to the final class day were similar for students who received an A, B, or C, for their final course grade. Therefore, final course grade does not appear to be a good indicator of improvement in critical thinking ability in an evaluation course over a semester (Shann et al., 2006).

**Methods**

This study attempted to determine whether differences exist between demographic and descriptive attributes of students with regard to critical thinking ability. Three courses were selected to represent the undergraduate population of animal science students at Clemson University. Students filled out a questionnaire we designed and completed the WGCTA exam. Students enrolled in the different courses took the exam on two consecutive days. Methodology was approved by the Institutional Review Board (IRB) at Clemson University.

**Population**

The target population was all students enrolled in the Animal and Veterinary Science curriculum. The sample population consisted of students enrolled in Equine Evaluation (n=15), Livestock Evaluation (n=19), and Animal Reproduction (n=44) within the department of Animal and Veterinary Sciences at Clemson University.
Instrumentation

The *Waston-Glaser Critical Thinking Appraisal* (WGCTA) test, forms A and B, from Harcourt Assessment, was used to objectively assess student critical thinking ability. The WGCTA seeks to provide an estimate of an individual’s standing on a composite of attitude, knowledge, and skills by means of evaluating the student’s ability to think critically in five categories; 1) Inference, 2) Recognition of Assumptions, 3) Deduction, 4) Interpretation, and 5) Evaluation of Arguments. Categories are weighted equally and final score is on a 0-80 scale.

Students were asked to complete a questionnaire to determine demographic information (Appendix B-1). This questionnaire was utilized to formulate relationships between specific demographic information and critical thinking ability as measured by the WGCTA exam. The questionnaire identifies characteristics of each student with respect to age, gender, classification level in school, GPA, and previous judging experience. Each of these characteristics was self-reported by the student and therefore may contain a certain level of bias.

Data analysis

The data were coded and analyzed using Microsoft Office Excel and SPSS 17.0.1 for Mac OS X (SPSS, 2009), and SAS for Windows (SAS Inst. Inc., Cary, NC). Descriptive and inferential statistics were used to analyze the data. Descriptive statistics utilized included means, averages, and percentages. Inferential statistics utilized included analysis of variance (ANOVA) using both SPSS and the PROC GLM procedures of SAS (SPSS, 2009; SAS Inst. Inc., Cary, NC), and a t-test to determine relationships between
critical thinking skill level and certain demographic and descriptive attributes of students.

Finally, a post hoc Tukey test was conducted to determine relationships among variables when ANOVA determined a P value of 0.05 or less.

Results

Mean score and standard deviation for all students on the pre-test WGCTA exam was 58.4 ± 7.00 on an 80 point scale. ANOVA revealed no first or second order interactions between the demographic variables (Table 5.1) using PROC GLM of SAS (SAS Inst. Inc.). Interaction effects reported in Table 5.1. Because no interactions were found, results from individual demographic comparisons are presented below.

Table 5.1. First order interactions of demographic variables.

<table>
<thead>
<tr>
<th>Interactions</th>
<th>Mean Square</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification*age</td>
<td>38.3</td>
<td>0.33</td>
</tr>
<tr>
<td>Classification*GPA</td>
<td>38.3</td>
<td>0.48</td>
</tr>
<tr>
<td>Classification*gender</td>
<td>65.0</td>
<td>0.22</td>
</tr>
<tr>
<td>Classification*judging</td>
<td>42.1</td>
<td>0.37</td>
</tr>
<tr>
<td>Age*GPA</td>
<td>7.1</td>
<td>0.91</td>
</tr>
<tr>
<td>Age*gender</td>
<td>0.01</td>
<td>0.99</td>
</tr>
<tr>
<td>Age*judging</td>
<td>7.0</td>
<td>0.68</td>
</tr>
<tr>
<td>GPA*gender</td>
<td>6.0</td>
<td>0.93</td>
</tr>
<tr>
<td>GPA*judging</td>
<td>37.8</td>
<td>0.41</td>
</tr>
<tr>
<td>Gender*judging</td>
<td>16.8</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Age

Students were grouped by age: 18-20; 21-24; and >24. There were 43 students in the 18-20 group, 38 in the 21-24 group, and 2 in the >24 group. Because the >24 group was so small, data were combined with the 21-24 group (Table 5.2). Students in the 18-20 age group averaged 64.2 ± 6.34. Students in the >20 age group averaged 58.4 ± 7.65.
ANOVA results are recorded in Table 5.2. Students in the 18-20 age range scored higher (P=0.039) than students in the >20 category.

Table 5.2. Results for differences in critical thinking score with regard to age.

<table>
<thead>
<tr>
<th></th>
<th>18-20</th>
<th>&gt;20</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>43</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>64.2</td>
<td>58.4</td>
<td>0.0039</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>6.34</td>
<td>7.65</td>
<td></td>
</tr>
</tbody>
</table>

Classification

Students were classified as: sophomores (n=24); juniors (n=33); and seniors (n=26), ANOVA results and descriptions of each group are listed in Table 5.3. No significant differences in critical thinking ability were observed for classification level of students (P=0.280).

Table 5.3. ANOVA results for differences in critical thinking score with regard to classification in school.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>125.88</td>
<td>2</td>
<td>62.94</td>
<td>1.29</td>
<td>.280</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3892.19</td>
<td>80</td>
<td>48.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4018.07</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gender

Participants in the study were 79% female (n=65). This study found no significant differences in gender for critical thinking ability (P=0.47). Males averaged 61.7 ± 7.1, and females averaged 59.1 ± 7.0, results are reported in Table 5.4.
Table 5.4. Results for differences in critical thinking score with regard to gender.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>18</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>61.7</td>
<td>59.1</td>
<td>0.47</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>7.1</td>
<td>7.0</td>
<td></td>
</tr>
</tbody>
</table>

GPA

Students were grouped into five GPA categories. Only 2 students fell in 1.5-2.09 category (2 %), 8 in the 2.1-2.49 (10 %), 26 students fell in the 2.5-2.99 range (31 %), 22 in the 3.0-3.49 (27 %), and 25 fell in the >3.49 range (30 %). Because of low n, the 1.5-2.09 and 2.1-2.49 groups were combined. ANOVA reported a significant difference (P=0.05) between the GPA groups, so a post hoc Tukey test was run to determine exact differences. ANOVA results are reported in Table 5.5.

Table 5.5. ANOVA results for differences in critical thinking with regard to GPA.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>608.18</td>
<td>3</td>
<td>202.73</td>
<td>4.70</td>
<td>0.05</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3409.89</td>
<td>79</td>
<td>43.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4018.07</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Tukey post hoc results indicated students in the >3.49 GPA category scored significantly higher (P=0.003) on the WGCTA than the 2.5 – 2.99 category. The >3.49 group tended to score higher than the <2.49 group (P=0.12). All results are listed in Table 5.6.
Table 5.6. Tukey post hoc results showing differences in critical thinking score with regard to GPA category.

<table>
<thead>
<tr>
<th>GPA Category</th>
<th>Difference Mean</th>
<th>Std. Error</th>
<th>P</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2.49 vs. 2.5-2.99</td>
<td>1.262</td>
<td>2.44</td>
<td>.96</td>
<td>-5.15</td>
<td>7.68</td>
</tr>
<tr>
<td>3.0-3.49 vs.</td>
<td>-1.38</td>
<td>2.51</td>
<td>.95</td>
<td>-7.96</td>
<td>5.19</td>
</tr>
<tr>
<td>&gt; 3.49 vs.</td>
<td>-5.44</td>
<td>2.46</td>
<td>.129</td>
<td>-11.89</td>
<td>1.01</td>
</tr>
<tr>
<td>2.5-2.99 vs. 3.0-3.49</td>
<td>-2.64</td>
<td>1.90</td>
<td>.50</td>
<td>-7.64</td>
<td>2.35</td>
</tr>
<tr>
<td>&gt; 3.49 vs.</td>
<td>-6.70</td>
<td>1.84</td>
<td>.003</td>
<td>-11.53</td>
<td>-1.87</td>
</tr>
<tr>
<td>3.0-3.49 vs. 2.5-2.99</td>
<td>1.38</td>
<td>2.51</td>
<td>.95</td>
<td>-5.19</td>
<td>7.96</td>
</tr>
<tr>
<td>&gt; 3.49 vs. 2.5-2.99</td>
<td>2.64</td>
<td>1.90</td>
<td>.51</td>
<td>-2.35</td>
<td>7.64</td>
</tr>
<tr>
<td>&gt; 3.49 vs. &lt; 2.49</td>
<td>-4.06</td>
<td>1.92</td>
<td>.16</td>
<td>-9.10</td>
<td>.98</td>
</tr>
<tr>
<td>2.5-2.99 vs. 3.0-3.49</td>
<td>5.44</td>
<td>2.46</td>
<td>.129</td>
<td>-1.08</td>
<td>11.89</td>
</tr>
<tr>
<td>&gt; 3.49 vs. &lt; 2.49</td>
<td>6.70</td>
<td>1.84</td>
<td>.003</td>
<td>1.16</td>
<td>11.53</td>
</tr>
<tr>
<td>3.0-3.49 vs.</td>
<td>4.06</td>
<td>1.92</td>
<td>.16</td>
<td>-9.84</td>
<td>9.10</td>
</tr>
</tbody>
</table>

Previous judging experience

Students were asked to indicate their level of experience with animal evaluation training on the demographic questionnaire. Students were required to describe their evaluation training experience, whether it was during highschool (4-H, FFA) or college (evaluation courses/teams). Students with 1 semester or more of evaluation experience (n=25) were compared with students who had no evaluation experience whatsoever (n=58). Students who had previously been involved in evaluation/judging activities scored significantly higher (P<0.0009) on the WGCTA compared to students who had no previous judging experience (64 vs. 59, respectively). Results reported in Table 5.7.
Table 5.7. Results for differences in critical thinking score with regard to previous judging experience.

<table>
<thead>
<tr>
<th></th>
<th>Previous Experience</th>
<th>No Experience</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>25</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>64</td>
<td>59</td>
<td>0.0009</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>6.1</td>
<td>7.2</td>
<td></td>
</tr>
</tbody>
</table>

**Discussion and Conclusions**

Differences of descriptive and demographic information exist in the Animal and Veterinary Sciences undergraduate population studied at Clemson University. Of the information assessed, age, GPA, and previous judging experience do appear to be useful descriptors related to critical thinking ability. Classification level in school and gender do not appear to accurately describe critical thinking ability of students. This information is beneficial, and can be utilized by instructors and the curriculum committee. While changing a curriculum to accommodate a single group of students is not possible, understanding that differences do exist, and altering some discourse or activities presented to students is possible. It is possible, however, to require certain courses known to enhance critical thinking ability, such as evaluation courses and activities. Understanding the specific activities that contribute to critical thinking ability, that are housed in evaluation training is beneficial if those activities can be adapted and applied to other courses.
The difference in critical thinking score for the two age groups contradicts the majority of studies in which age showed no significant effects on critical thinking ability (Facione, 1990; Facione, 1991; Jenkins, 1998; Rudd et al., 2000; Ricketts and Rudd, 2005). Findings agree with previous research that found differences in performance on critical thinking and higher order thinking tests with respect to age, however, previous research found an increase in critical thinking ability with an increase in age, which is directly inverse to the findings here, as the youngest age group (18-20) scored higher than the >20 group (Cano 1993; Cano & Martinez 1995). Since older students scored lower than their younger peers (P<0.04), opportunities to continually challenge and develop critical thinking skills in upperclassmen should be investigated and implemented. This holds true for students with a lower GPA, although it may be more difficult to put into action.

Males and females did not score differently on the WGCTA (P=0.47). Results from this study are consistent with those of Torres and Cano (1995), Ricketts and Rudd (2005), and Friedel et al., (2006) who observed no significant influences of gender on ability to think critically. In contrast, a study by Wilson (1989) observed gender as a significant indicator of critical thinking skill among college freshman (n=203) using the WGCTA exam.

Students with a higher GPA scored higher on the standardized critical thinking test. Research shows similar differences of critical thinking scores with regard to GPA (Giancarlo, 1996, Jenkins, 1998, Thompson, 2001). GPA has been shown to be a factor in at least portions of critical thinking constructs on the California Critical Thinking...
Disposition Inventory (CCTDI) and researcher developed critical thinking skills tests (Giancarlo and Facione, 2001, and Ricketts and Rudd, 2005).

The finding that previous judging experience does indicate higher critical thinking scores in students is persuasive. Animal science curricula should require evaluation courses as part of a well rounded program of study for all students in order to enhance critical thinking ability. Evaluation experience has been linked to development of decision making and problem solving skills (Rusk et al., 2002).

It is recommended that opportunities for critical thinking be built into every possible classroom situation, regardless of the type of student (Kauffman et al., 1971; Taylor & Kauffman, 1983; Schillo, 1997). Teaching practices must be evaluated to ensure that everyone has an equal opportunity to perform. It is vital for teachers to understand that demographic information can play a role in current and possibly future critical thinking ability. A better understanding of demographic information and critical thinking ability is needed. Future research should take a closer look at the relationship of age and ability to think critically. This study combined ages that represent the main division between under and upper classmen into one group (18-20). It would be interesting to further investigate this age range. A more in-depth look at previous judging experience would also be useful. A better description of when the evaluation training took place, for how long, and of what type would provide valuable information.
CHAPTER SIX

APPRAISAL OF CRITICAL THINKING SKILLS IN ANIMAL SCIENCE UNDERGRADUATES WHO PARTICIPATED ON A COMPETITIVE COLLEGIATE JUDGING TEAM.

Abstract

Evaluation courses have remained an integral part of collegiate animal science programs throughout the country and are a precursor for a national judging team. An evaluation course focuses on teaching students generally accepted criteria for evaluating a particular animal, industry standards and rules to compare multiple animals, and emphasizes students being able to defend their judgments both written and orally. These skills are necessary for building well-rounded graduates. Participation on a judging team has been associated with developing problem solving and decision making skills, employer preferred life skills (Boyd, et al., 1992; Rusk et al., 2002). Eight students in the Department of Animal and Veterinary Sciences at Clemson University completed a standardized critical thinking exam in Spring 2007. Four of the students had never taken an evaluation course or competed on a judging team (N) and the remaining four had competed on a national judging team (J). All students were similar in regards to age, gender, classification and GPA. Because of the low sample size, and lack of a pre-test, the tentative conclusion that we can draw from this exercise is that students who have participated in national horse judging contests subsequently demonstrate a higher level of critical thinking ability.
Introduction

It is imperative that college of agriculture graduates possess a balanced combination of base knowledge and independent thought combined with critical thinking ability. Recent advances and restructuring of the workplace has increased emphasis on teamwork. Not only are employees expected to think creatively, solve problems, and make decisions, they are expected to perform as part of a team (Gokhale, 1995). Gokhale (1995) describes critical thinking attributes as analysis, synthesis, and evaluation of concepts. Previous research shows that senior students in a college of agriculture scored lowest on a critical thinking ability construct in comparison to basic cognitive ability and applications ability constructs (Torres and Cano, 1995). Many students are graduating with less than adequate cognitive skills that are vital to solve problems and make decisions (Torres and Cano, 1995). The college experience must prepare graduates for the experiences that lie ahead, which includes thinking critically, individually and as a member of a team.

Participation on a horse judging team exposes a student to analytical and critical thinking, judgment, and written and oral communication skills. Students first learn general judging criteria for a particular species, multiple species, or performance events. Students are taught conformation and performance standards, practice evaluating multiple animals against the breed standard, then rank the animals in order of best fit to the ideal. Students utilize known criteria to critically and independently evaluate classes, and develop written and oral justification (reasons) for judgments. Students learn to develop reasons for their assessment and give the justification to a professional in an oral
presentation format. In relation to higher orders of cognition described by Bloom et al. (1956), participation on a judging team involves a significant amount of critical thinking: application of criteria for evaluating animals, analysis of individual classes, synthesis of criteria, and evaluation of multiple disciplines. Logically, it makes sense that an activity utilizing higher order thinking would produce a student better equipped to handle thinking critically. Researchers (Gokhale 1995) studied individual and group exercise outcomes and concluded that students who participated in collaborative learning as a team performed significantly (P=0.001) higher on a critical thinking test. Students participating in collaborative learning indicated that participation as a group stimulated thinking and facilitated understanding.

Researchers in Missouri (Shann et al., 2006) examined critical thinking ability using the WGCTA of undergraduate students (n=63) enrolled in a live animal and meat evaluation course. Students were given either form A or form B on the first class day (pre-test) and again on the last class day (post-test); students that received form A initially received form B for the post-test, and vice versa. Course work included sixteen weeks of instruction in animal anatomy; live animal evaluation and pricing; carcass grading; carcass pricing; and ranking philosophies for beef, pork, and lamb. Researchers observed a significant improvement in critical thinking scores from the first to the last class day in undergraduate students (n=63) enrolled in a live animal and meat evaluation course using a standardized critical thinking appraisal exam (Shann et al., 2006). Students significantly improved their final WGCTA score from the first to the last class day (39.9 and 55.5, respectively).
Little research has looked specifically at the relationship of judging teams and their ability to foster critical thinking processes. The objective of this study, therefore, was to quantify the critical thinking ability of students who had previously competed on an equine evaluation team and compare them to similar students who had not previously been a part of an animal evaluation team.

**Methods**

This study attempted to quantify the level of critical thinking ability in students who had previously participated on a national-level competitive judging team, and determine whether there was a difference when compared to students who had not previously had evaluation training.

The null hypothesis stated that students who had previously participated on an evaluation team scored the same on a critical thinking ability test as students who had no prior animal evaluation training. The alternative hypothesis stated that students who had prior judging experience scored differently on a critical thinking ability test than students who had no prior judging experience.

The experimental design was:

\[ \begin{array}{c}
X & O_1 \\
- & - & - & - \\
O_2
\end{array} \]

“\(O_1\)” represents the students participating in the judging experience, “\(X\)” is the treatment which occurred on a volunteer basis (judging experience), and “\(O_2\)” is the student group who did not receive the treatment.
Population

Eight students in the Animal and Veterinary Sciences department at Clemson University participated in the project. Students (J) who competed on a national level at horse judging contests in 2006 (n=4) and students (N) who had not competed on a judging team, or taken an evaluation course (n=4) were evaluated. Group N was similar to group J with regard to age, classification level in school, gender, and GPA. N students were identified from a pool of 82 students enrolled in one of three courses being used for an additional study in the Animal and Veterinary Sciences department at Clemson University. All testing and observation was approved by the Institutional Review Board (IRB) at Clemson University.

Instrumentation

Students filled out a questionnaire (Appendix B-1) designed to determine demographic information. This questionnaire was utilized to determine specific demographic information of the judging students and identified their peers whose demographic information was similar to them such that a comparison group could be made. The questionnaire identified characteristics of each student with respect to age, gender, classification, GPA, and previous judging experience. Each of these characteristics was self-reported by the student and therefore may not be completely accurate.

The Watson-Glaser Critical Thinking Appraisal (WGCTA) test, forms A and B, from Harcourt Assessment provided means to objectively assess a student’s critical thinking ability. The WGCTA provides an estimate of an individual’s standing on a
composite of attitude, knowledge, and skills by means of evaluating the student’s ability
to think critically in five categories; 1) Inference, 2) Recognition of Assumptions, 3)
Deduction, 4) Interpretation, and 5) Evaluation of Arguments. Each category is weighted
equally and the test is on an 80 point scale.

Collection

Four students who had previously participated on a nationally competitive horse
judging team were identified by the judging team coach in the department of Animal and
Veterinary Sciences in spring 2007. These were four of the five who had competed at
national horse judging contests in fall 2006. One student had graduated in December and
was not available to take the WGCTA. A concurrent study (n=83) was utilizing the
WGCTA and the demographic questionnaire (Appendix B-1) in spring 2007. Of the 83
students tested in the alternate study, four were identified that matched the demographic
characteristics of the judging students exactly, except for judging or evaluation
experience (Table 3.1). The four students (N) reported they had never received any
animal evaluation training. Pre-test scores from the N students involved in the additional
study served as the control group with which to compare the J scores. Judging (J)
students took the WGCTA on the two consecutive days that the non-judging (N) students
took the WGCTA for the additional study.

Demographic information for eight students is listed in Table 3.1.
Table 6.1. Self reported demographic information for (J) judging team members and (N) control group of students.

<table>
<thead>
<tr>
<th>Student</th>
<th>Classification</th>
<th>Age Range</th>
<th>GPA</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>J 1</td>
<td>Junior</td>
<td>18-20</td>
<td>&gt;3.4</td>
<td>Male</td>
</tr>
<tr>
<td>J 2</td>
<td>Junior</td>
<td>21-24</td>
<td>2.5-2.9</td>
<td>Female</td>
</tr>
<tr>
<td>J 3</td>
<td>Junior</td>
<td>18-20</td>
<td>2.5-2.9</td>
<td>Female</td>
</tr>
<tr>
<td>J 4</td>
<td>Junior</td>
<td>21-24</td>
<td>&gt;3.4</td>
<td>Female</td>
</tr>
<tr>
<td>N 1</td>
<td>Junior</td>
<td>18-20</td>
<td>&gt;3.4</td>
<td>Male</td>
</tr>
<tr>
<td>N 2</td>
<td>Junior</td>
<td>21-24</td>
<td>2.5-2.9</td>
<td>Female</td>
</tr>
<tr>
<td>N 3</td>
<td>Junior</td>
<td>18-20</td>
<td>2.5-2.9</td>
<td>Female</td>
</tr>
<tr>
<td>N 4</td>
<td>Junior</td>
<td>21-24</td>
<td>&gt;3.4</td>
<td>Female</td>
</tr>
</tbody>
</table>

Data analysis

All data were coded and analyzed using Microsoft Excel for Windows. Data were analyzed for mean and standard deviation of each category of the WGCTA and final score for both groups (J and N). Raw scores were then standardized and compared using a z-score. Final score means were compared to published national norms for college students (Watson and Glaser, 1980).

Results

Group J scored in the 60th percentile (mean=56.25) while group N scored in the 45th percentile (mean=53.5) when compared to national averages. Mean score for both groups was 54.9 ± 6.85. Z-scores for J and N were 0.197 and -0.204, respectively. This means that average scores for both groups differed 40% of a standard deviation compared
to the mean for both groups. The mean score for group J was higher than or equal to 57.8% of the individual student scores in both groups and the mean for group N was higher than or equal to 41.9% of the individual student scores in both groups. Group J scored numerically higher than the N group on the Recognition of Assumptions and Evaluations of Arguments portions of the WGCTA exam compared to group N (12.5 and 12.75 vs. 8.75 and 12, respectively). All results are reported in Table 3.2.

Table 6.2. Mean WGCTA scores for judging team members and control, including standard deviation and Z-score.

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inference</td>
<td>8.25</td>
<td>8.5</td>
</tr>
<tr>
<td>Recognition of</td>
<td>12.5</td>
<td>8.75</td>
</tr>
<tr>
<td>Assumptions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deduction</td>
<td>10.25</td>
<td>10.5</td>
</tr>
<tr>
<td>Interpretation</td>
<td>12.5</td>
<td>13.75</td>
</tr>
<tr>
<td>Evaluation of</td>
<td>12.75</td>
<td>12</td>
</tr>
<tr>
<td>Arguments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total score</td>
<td>56.25</td>
<td>53.5</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>6.55</td>
<td>7.85</td>
</tr>
<tr>
<td>Z-score</td>
<td>0.197</td>
<td>-0.204</td>
</tr>
</tbody>
</table>

Discussion and Conclusions

Tangible benefits of participation on a judging team are not well documented. Judging competitively at the collegiate level may increase critical thinking ability above peers who have not competed on a judging team. Popular opinion is that students gain valuable skills in higher order thinking by being an active participant on an animal evaluation team, and research shows that participation in extra-curricular activities is
beneficial to enhancing critical thinking ability (Gellin, 2003; Shann et al., 2006). However, more technically based science education is becoming more commonplace, taking the place of hands-on experiences. While each is beneficial to the student, a clear interpretation of benefits derived from each is warranted. When asked what benefits were derived from their experience on a judging team, respondents indicated that their experience was most essential to the development of decision making and problem solving skills (Rusk et al., 2002). Judging teams typically involve a small number of students at a particular university and can be quite expensive to support; however, the benefits out-weigh the disadvantages.

Students participating on a competitive judging team demonstrate numerically higher critical thinking scores and score higher relative to national norms compared to their peers who have not previously had any animal evaluation training. Offering opportunities to students, including involvement on a competitive judging team, should be utilized and supported as an important aspect of higher education. Contributing to a student’s knowledge by providing facts in a classroom is not enough; a student must be able to demonstrate understanding of concepts in hands-on projects, including intercollegiate competition (Kauffman et al., 1971). In order to produce students with critical thinking abilities, it is imperative to make opportunities available that will challenge them, thus creating an individual capable of independent thought and critical thinking; valuable skills for the workplace (Boyd et al., 1992).
CHAPTER SEVEN

FINAL CONCLUSIONS AND RECOMMENDATIONS

With the magnitude of the financial crisis that now faces America, it is essential to have leaders capable of making sound decisions that are based on accurate knowledge and prudence for impacts those decisions will have on the future. While the objectives contained in this dissertation are broad, the one underlying focus of each is higher order thinking of undergraduate students in an animal science department. Not only will these students prevail as leaders at their university, but across the nation. Previous research, theory, and opinion tell us that critical thinking is an important topic, and the major theme across each objective detailed here echoes the claim; higher order thinking is an important attribute for our students. Animal science departments are becoming increasingly diverse and specialized across the country. Some cornerstone courses have come under attack regarding their usefulness and contribution to a quality undergraduate education, and in some cases they have been done away with. A specific group of such courses are evaluation courses. These typically include livestock, dairy, meat, and equine; but can include wool, turf, soils, etc. Attributes of evaluation courses are not well documented, and, where they are documented, details are based mainly on opinion and anecdotal experiences of participants. The number of faculty who disagree with the beliefs that evaluation teams and courses provide worthwhile learning opportunities for students has grown over the last decade, as emphasis has shifted toward research supported by extramural funding. Therefore, a solid examination and understanding of the benefits of evaluation activities is needed. The four objectives of this dissertation
attempted to do exactly that by comparing students who previously competed on a judging team to students who had not, examining in and out of class activities for evaluation vs. non-evaluation courses, and investigating the improvement in critical thinking scores of students in an evaluation course. Across all objectives, the results were similar, students enrolled in evaluation courses or who participated on judging teams scored higher on critical thinking exams. The possible reason for this influence was the greater total number of challenges given to students that required higher order thinking to complete. Students participating on judging teams and in evaluation courses were submerged in higher order thinking continuously over time.

**Implications**

Implications for findings gleaned from these studies are numerous and span a host of people, including administrators, curriculum committees, faculty, and individual undergraduate students.

Research exists that supports evaluation courses as an important component of Animal Science curricula. Where popular opinion previously was the main proponent of evaluation courses, hard evidence can now back it up. Evaluation courses offer greater total challenges to their students than non-evaluation courses. The cognitive level of thought processes required to complete these challenges is mainly (over 70%) at the highest levels of cognition. Higher order thinking skills were also modeled for students in the classroom as evidenced by the high levels of cognition exhibited during discourse which is beneficial in helping the student understand what level of performance expected of them. Incorporating many avenues for students to function at the highest level of
cognitive domain almost certainly increased critical thinking skills of students in the
evaluation course during a semester, when compared to students not enrolled in an
evaluation course (P=0.0001).

The value of evaluation courses is not only being questioned in some institutions,
but the level of commitment to seeing evaluation courses and judging teams succeed is
being undermined. Many believe that animal science curricula should evolve to a more
scientific, more molecular, more rigorous focus, and leave the teaching of production and
hands-on standards to the industry. While I am not questioning the need for
incorporating cutting edge content into the animal science curriculum, the benefits of
hands-on evaluation courses and extra-curricular activities are not unknown. Higher
order thinking skills derived from practical evaluation courses benefit all students as
future citizens, regardless of career interest. Alternatively, science instructors could
model classroom activities on evaluation courses, articulating and incorporating
increasingly higher order activities into their largely lecture style classrooms. A well-
rounded program of study in animal science should include both scientific and hands-on
course work, as the benefits of each are not mutually exclusive. Departments must
consider this activity (judging teams) and prerequisite course (evaluation) an important
endeavor and support them with available resources. While few students compared to the
total departmental enrollment will be active as a judging team member, the students who
are willing to commit the time and effort required to be successful in this venture will be
benefit greatly. The department will be better because of these students in return. Not
only will the department be known nationally at judging contests that typically coincide
with large industry events; but also this activity fosters a good work ethic, as the mentality of a judging team is laden with hard work and a positive attitude. A student successful in this activity will help by example to encourage other students in the department to work hard. Students participating on a judging team will graduate with the ability to think critically and make quality independent decisions, a positive attribute for constituents of our country. Doing away with evaluation courses as a part of a well-rounded program of study is not a sound option. Faculty and administrators in charge of developing curricula need to be made aware of benefits of evaluation courses in a curriculum.

In order to develop critical thinking skills in their students, instructors must take charge of their classroom and be integral in developing higher order thinking opportunities for them. First, the instructor must understand critical and higher order thinking, their components, and be well versed in the direct benefits to students. Secondly, the instructor must be well prepared for the semester by determining the appropriate cognitive level of instruction and challenges that should take place before the start of class. Of course several factors will determine the cognitive level of instruction and challenges, including expected cognitive level of students, level and scope of course, whether there is prerequisite course material expected to have been mastered, whether an overview of material is warranted, and end goals and objectives of the course. Once all of these attributes have been taken into consideration, the course can be broken down into sections, and instructors can determine the appropriate cognitive level for discourse and challenges for each section. For example, if the first two weeks of a course will be a brief
overview of material that the instructor expects the students to already know, low levels of cognition are more appropriate during discourse than if the information is more novel. The cognitive scope of the course may deviate from the original plan, depending on the abilities of the students. When new material is presented to the class, instructors can strive to incorporate challenges that will utilize higher order thinking in the students to relate new material to material previously learned.

In order to derive maximum benefit from their educational experience, students must take an active role in their own education. An understanding of higher order thinking is not necessary; put simply, the student must possess a desire to truly learn. If a student’s only aspiration is to learn material required to pass a course, then I am not positive that genuine and lasting higher order thinking skills can be achieved. Parents and students alike must understand the importance of higher order thinking and the benefits that can be attained from quality analytical and critical thinking combined with independent decision making skills. These skills can last a lifetime and may mean the difference between a mediocre future and a very successful one.

Parents should be concerned with finding an institution that will properly prepare their child for a successful life. As adults in the workforce, students will be expected to make profitable decisions in a demanding world, and if they are not up to the task, someone is waiting in the wings to take their place. Therefore, parents should care where a substantial portion of their paycheck is going each year and encourage their children to attend a university that lives up to their standards. A university that understands the challenges facing a graduating student and who continually strives to develop higher
order thinking attributes in their students is deserving of consideration. A university that puts emphasis on the importance of teaching, challenging, and offering opportunities to students at the highest levels of cognition is not only worth consideration, but endorsement.

Research shows that the majority of students beginning college courses are not able to operate at higher levels of cognition (Witkin, 1981; Whittington & Newcomb, 1993; Rudd et al., 2000). Perhaps a deeper look is warranted at the curriculum and expected outcomes of high school education. It is unfair to expect a student to think critically their freshman year in college if they have not received proper training in high school and been given time to develop those talents. It is equally unfair, to students and university instructors, to expect college training to be the sole provider of critical thinking skills. The academic path in higher education is much more malleable than instruction received in high school. University students are, to some extent, allowed to choose the focus of their course work and the order in which they complete required courses. Because of this, college students are at a disadvantage if courses are taken out of the recommended sequence, even when curriculum committees determine the most optimal order and lay it out plainly for them. A high school curriculum is much more structured and inflexible. Students take courses in sequences from year to year, which are very similar to those at other high schools in the area, state, and nation. While university curricula are similar for a given major at different universities, they are not as parallel as high school curricula; therefore, implementing a structured lesson plan that will begin to develop critical thinking skills should start in high school. If high school students are
taught in a way that augment higher order thinking, undergraduates will be more uniformly prepared to face college challenges. Further, students not entering college will have a greater advantage to incorporate higher order thinking throughout their lives.

It is evident that many courses are missing the bar on higher order thinking. Instructors must make an effort to determine appropriate level of cognition for all sections of a course and strive to implement them. Results of this study showed that students enrolled in non-evaluation courses received little discourse at the highest levels of cognition, and equally were challenged very little at the highest levels of cognition. Final course grade was being determined, on average, at higher levels of cognition than either instruction or challenges presented. This is skewed and should be remedied in the non evaluation courses examined.

For the courses where discourse was primarily at the lowest levels of cognition, generally a lecture style classroom was documented. A lecture style classroom was one where the instructor lectured consistently without asking questions or challenging the students. Students in these courses were required to complete assignments and tests that incorporated the material learned in the lecture classroom at higher levels of cognition than any that was modeled for them during discourse. Theory states that a student depends on the instructor to model desired behavior in the classroom, and the students’ attempts at higher order thinking must be rewarded in order for them develop good critical thinking skills and use the skills outside of the classroom (Kail & Cavanaugh, 2007). This theory was backed up with results from the change in critical thinking score of the non evaluation course compared to the evaluation course. Students in a mainly
lecture style setting (non evaluation) exhibited a lower change in critical thinking score compared to students in hands-on classrooms (evaluation) that incorporated higher order interaction between the instructor and students.

Future studies

Understanding course work and discourse is essential to improving the quality of the classroom and the student. Once instructors take an active role in increasing the cognitive level of teaching and testing, a student more proficient at higher order thinking will be produced. A clearer way to incorporate higher order thinking is paramount. Therefore, future research needs to be aimed at understanding what type of activities and challenges truly enhance critical thought processes in undergraduate students. A smart place to start would be to perform case studies utilizing instruction methods that are thought to develop or utilize higher order thinking. The specific reasons evaluation courses have been shown to utilize higher order thinking in discourse and challenges should be investigated, and those elements of evaluation courses should be adapted to more traditionally lecture style courses to enhance critical thought. Activities, including placing animals and giving reasons, in evaluation courses are unlike typical activities in mainstream animal science courses. Strategies employed by evaluation courses and judging teams should be extrapolated to fit in a variety of courses and topics in animal science programs.

Other opportunities for higher order thinking should be investigated. Experiential learning is a hot topic for teaching portfolios nationwide. Experiential learning is when a student has a concrete experience, makes observations and reflections about the
experience to form ideas and concepts, then applies those judgments to new experiences (Kail & Cavanaugh, 2007). This description follows that of critical thinking, and it is expected that well planned activities that utilize experiential learning in the classroom would enhance higher order thinking. Problem based learning involves a well defined problem with solutions embedded in the context of the problem. Students have to dissect information and make generalizations to solve, which would purportedly contribute to higher order thinking.

Regardless of the type of activity or teaching style being studied, it is necessary to understand instructor knowledge of and anticipated usage of higher order thinking in the classroom. It is also paramount to have a pre-test, post-test interpretation of student’s critical thinking skills. Keeping accurate records of cognitive level of teaching, testing, and grading, over the course of several semesters, is the only way to truly understand the change in cognition level over time.

Continuing to understand the benefit of judging programs is also a useful enterprise. It would be interesting to understand the critical thinking ability of truly outstanding collegiate judging team members; specifically to determine whether that group is more prone to higher order thinking, or whether they score higher on critical thinking tests. Even before they become judging team members, are students with a greater aptitude for critical thought more likely to do well in the judging arena. It would benefit animal science departments to understand whether participation on a judging team is beneficial to a wide variety of career paths because of the critical thought processes developed.
While the students used for these studies were animal science undergraduates at a Southeastern university, I believe they represent a “Slice of Life” (Oliver & Hinkle, 1981). Just like the classes they take to fulfill the requirements of their degree are similar to classes in other animal science departments across the country, they too are similar to other animal science undergraduates.

Many daily activities at a university deter us from continuously striving to develop good thinkers of our undergraduates. Some days the university setting is similar to a sheet in the wind, blowing whichever way the money appears; however, the rock solid foundation of a university is the undergraduate population, and the underlying theme for them is a quality education that best prepares them for the road ahead. Regardless of path chosen, quality decision making, an attribute of higher order thinking, is essential. The current financial crisis has mandated that much of the business world, in addition to the private sector, get back to the basics. A university is no exception.
Appendix A

Institutional Review Board at Clemson University Approval

Figure A-1: IRB approval for research

To: Imorga2@CLEMSON.EDU
From: Daniel Harris <dharri2@CLEMSON.EDU>
Subject: Validation of IRB application # IRB2006-290 entitled
"Quantifying the Improvement of Critical Thinking Skills Obtained from
Taking an Evaluation Class Measured by Watson-Glaser Critical Thinking
Appraisal Exam"

Subject: Validation of IRB application # IRB2006-337 entitled
"Determining cognitive level of academic challenges presented to
students by professors..."

Dear Dr. Morgan:

The Chair of the Clemson University Institutional Review Board (IRB) validated the proposal
identified above using Exempt review procedures and a determination was made on
December 6, 2006 that the proposed activities involving human participants qualify as Exempt
from continuing review under Category 1 based on the Federal Regulations. You may begin
this study.

Please remember that no change in this research proposal can be initiated without prior review
by the IRB. Any unanticipated problems involving risks to subjects, complications, and/or any
adverse events must be reported to the IRB immediately. The Principal Investigator is also
responsible for maintaining all applicable protocol records (regardless of media type) for at
least three (3) years after completion of the study (i.e., copy of validated protocol, raw data,
amendments, correspondence, and other pertinent documents). You are requested to notify
the Office of Research Compliance (ORC) if your study is completed or terminated.

Attached are documents developed by Clemson University regarding the responsibilities of
Principal Investigators and Research Team Members. Please be sure these are distributed to
all appropriate parties.

Good Luck with your study and please feel free to contact us if you have any questions. Please
use the IRB number and title in all communications regarding this study.

Daniel Harris
IRB Program Assistant
Office of Research Compliance
223 Brackett Hall
Clemson University
Clemson, SC 29634-5704
dharri2@clemson.edu
Phone: 864-656-0636
Fax: 864-656-4475
www.clemson.edu/research/orcSite/indexComply.htm

92
Appendix B

Forms utilized in studies

Figure B-1: Questionnaire for students taking the WGCTA exam.

<table>
<thead>
<tr>
<th>Name:</th>
<th>Testing No.:</th>
</tr>
</thead>
</table>

*Please take your time to answer every question truthfully and to the best of your ability.*

1. Please indicate your classification by circling the appropriate response:
   - Freshman
   - Sophomore
   - Junior
   - Senior

2. Please indicate your age by circling the appropriate range:
   - 18-20
   - 21-24
   - >24

3. Please indicate your GPA by circling the appropriate range:
   - < 1.5
   - 1.5 – 2.0
   - 2.1 – 2.4
   - 2.5 – 2.9
   - 3.0 – 3.4
   - > 3.4

4. Please indicate your gender by circling the correct response:
   - Male
   - Female

5. Have you ever been involved in a judging program before (i.e.: 4-H, FFA, or evaluation class in college)?
   - Yes
   - No
Figure B-2: Methods for evaluating discourse and challenges.

<table>
<thead>
<tr>
<th>Research Activity</th>
<th>How evaluated</th>
<th>Time spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse evaluation</td>
<td>Students observed class and recorded events. Time was recorded exactly and all</td>
<td>Observing: 1 hr – 3 hrs per class X 2 observations per semester for each class.</td>
</tr>
<tr>
<td></td>
<td>events were described in approximate 10 minute intervals.</td>
<td>Evaluation of discourse: 20 minutes per observation record</td>
</tr>
<tr>
<td></td>
<td>Students utilized Bloom’s Taxonomy key words to identify level of cognition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of questions and activities during discourse</td>
<td></td>
</tr>
<tr>
<td>Challenges evaluation</td>
<td>Participating instructors submitted copies of all challenges given to class</td>
<td>Evaluation of challenges: 20 minutes – 1 hour per challenge depending on</td>
</tr>
<tr>
<td></td>
<td>Each RA was given a separate record sheet for each of the challenges.</td>
<td>length.</td>
</tr>
<tr>
<td></td>
<td>Ra’s independently evaluated each challenges, then results were averaged</td>
<td></td>
</tr>
</tbody>
</table>
Figure B-3: Cognition record sheet for challenges.

<table>
<thead>
<tr>
<th>Cognition Record for:</th>
<th>Percent of final grade:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of challenges:</td>
<td>Evaluator Initials:</td>
</tr>
<tr>
<td><em>(don’t count number of questions, rather, count questions asked; i.e: some questions may have multiple parts)</em></td>
<td></td>
</tr>
</tbody>
</table>

Record a hash mark for each challenge that falls into the following categories:

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td></td>
</tr>
<tr>
<td>Comprehension</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td></td>
</tr>
<tr>
<td>Synthesis</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


Ewing, J.C., Carnes, A., and M.S. Whittington. 2006. Type, number, and cognitive level of academic challenges provided by professors. Proceedings from American Association of Agricultural Educators, Charlotte, NC.


SPSS Inc. 2009. SPSS 17.0.1 for Mac OS X. Chicago, Illinois.


