Assessment of the Critical Thinking Skills in an Animal Science Curriculum

Sarah Al-Mazroa, Dr. Michael Retallick, and Dr. Brad Skaar
Department of Agricultural Education
Iowa State University
What is Critical Thinking?

- “a reasoned, purposive, and introspective approach to solving problems or addressing questions with incomplete evidence and information for which an incontrovertible solution is unlikely” (Rudd, Baker, & Hoover, 2000, p. 5).
Critical Thinking Assessments

- Animal Science Department Utilizes the Critical Thinking Assessment Test (CAT) by Tennessee Technological University
  - STEM Based Questions
  - Fifteen Essay Questions
    - Four CT Domains:
      » Evaluate and Interpret Information
      » Problem Solving
      » Creative Thinking
      » Effective Communication
  - Faculty and staff score the exams according to a provided rubric
Background of Critical Thinking in the Animal Science Curriculum

- Fall 2013- Critical Thinking Assessment was performed on Seniors in Animal Science program
  - Utilized the Critical Thinking Assessment Test (CAT)
  - Senior scored:
    - At national norm for overall domains \( (p<0.05) \)
    - Seniors scored significantly below national norm
      - Skill Three: “Provide alternative explanations for a pattern of results that has many causes” \( (p<0.05) \)
Questions Left Unanswered from 2013 Critical Thinking Study

- What impact does the Department of Animal Science curriculum have on the animal science student’s critical thinking skills?
- What are the levels of critical thinking when the students enter the program?
- Where are critical thinking skills being taught in the curriculum?
- Are instructors effectively teaching critical thinking in their courses?
Objectives of Study

1. Compare Freshmen and Senior Animal Science students to the national critical thinking skill norms

2. Determine if there’s a difference between freshmen and senior Animal Science students in critical thinking

3. Determine if there’s a difference in critical thinking skills based upon selected demographic variables
Methods of Study

- **Instrument**
  - Critical Thinking Assessment Test (CAT)

- **Participants**
  - Freshmen (n=55): 17 males, 38 females
  - Seniors (n=60): 13 males, 47 females

- **Data Collection**
  - Students were enrolled in: AnS 110 or AnS 411
  - Freshmen: came to the university from high school
  - Seniors: took all their core animal science courses at the university
Assumptions and Limitations

Assumptions:
- Groups of students were randomly sampled to represent the department’s population
- Senior group had similar life and coursework experiences

Limitations:
- Number of students
- Time
  - The same student wasn’t tested as a freshmen and then as a senior
### Objective One: Results

**Freshmen**

<table>
<thead>
<tr>
<th>Skill Assessed by CAT</th>
<th>National Mean</th>
<th>Institution Mean</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q10) Separate relevant from irrelevant information</td>
<td>3.01</td>
<td>3.51**</td>
<td>+0.56</td>
</tr>
<tr>
<td>Q12) Use basic math skills when solving a real-world problem</td>
<td>0.75</td>
<td>0.89*</td>
<td>+0.37</td>
</tr>
<tr>
<td>Total CAT Score</td>
<td>13.66</td>
<td>15.19*</td>
<td>+0.32</td>
</tr>
</tbody>
</table>

Note: Significant at *p*<.05, **p*<.01
Objective One: Results
Seniors

<table>
<thead>
<tr>
<th>Skill Assessed by CAT</th>
<th>National Mean</th>
<th>Institution Mean</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2) Evaluate how strong data supports a hypothesis</td>
<td>1.21*</td>
<td>0.92</td>
<td>-.027</td>
</tr>
<tr>
<td>Q7) Identify additional information needed to evaluate a hypothesis</td>
<td>0.82**</td>
<td>0.57</td>
<td>-0.4</td>
</tr>
<tr>
<td>Q15) Explain how changes in a real-world problem situation might affect the solution</td>
<td>1.15**</td>
<td>0.69</td>
<td>-0.51</td>
</tr>
<tr>
<td>Total CAT Score</td>
<td>19.04*</td>
<td>17.47</td>
<td>-0.28</td>
</tr>
</tbody>
</table>

Note: Significant at *p<.05, **p<.01
Objective One: Conclusions

- Department of Animal Science **Freshmen** are able to critically think above the level of peer institutions.

- Department of Animal Science **Seniors** are not able to critically think at the level of peer institutions.
Objective One: Recommendations

- Typically, coursework starts at the lowest level of cognitive thinking and work the students up (Fisher and Grant, 1983)

- Challenge the freshmen right away in the program
  - Above national norm= start a higher level of critical thinking
### Objective Two: Results

**Overall Score Comparison**

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Std. Error</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshmen</td>
<td>0.68</td>
<td>15.19</td>
</tr>
<tr>
<td>Seniors</td>
<td>0.73</td>
<td>17.47*</td>
</tr>
</tbody>
</table>

Note: Significant at *$p<.05$*
## Objective Two: Results

### Critical Thinking Domains

<table>
<thead>
<tr>
<th>CT Domain</th>
<th>Freshmen</th>
<th>Seniors</th>
<th>p- value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate and Interpret Information</td>
<td>1.19</td>
<td>1.35</td>
<td>0.03*</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>1.26</td>
<td>1.41</td>
<td>0.08</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>0.8</td>
<td>0.97</td>
<td>0.02*</td>
</tr>
<tr>
<td>Effective Communication</td>
<td>0.92</td>
<td>1.14</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

Note: Significant at *<p-value<.05*
### Objective Two: Results

#### Individual Skill Comparison

<table>
<thead>
<tr>
<th>CT Skill</th>
<th>Senior Mean</th>
<th>Freshmen Mean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3) Provide alternative explanations for results</td>
<td>1.10</td>
<td>0.71</td>
<td>0.03*</td>
</tr>
<tr>
<td>Q5) Evaluate whether information supports a hypothesis</td>
<td>0.72</td>
<td>0.55</td>
<td>0.05*</td>
</tr>
<tr>
<td>Q11) Use and apply relevant information</td>
<td>1.28</td>
<td>1.00</td>
<td>0.03*</td>
</tr>
<tr>
<td>Q13) Identify solutions for a problem</td>
<td>1.22</td>
<td>0.80</td>
<td>0.02*</td>
</tr>
</tbody>
</table>

Note: Significant at *p*<.05
Objective Two: Conclusions

- There’s a significant difference between the two grade levels ability to critically think
  - Might have multiple factors to cause the change

- Even with change in the two grade levels, seniors don’t achieve the level that other institutions are providing for their students
Objective Two: Recommendations

- Start at a level of critical thinking according to the freshmen’s ability
- Integrate critical thinking in curriculum as the overall outcome of the program (Broadbear, 2012; Swartz, 2000)

- Implement new teaching techniques
  - Problem-solving based assignments (Wagner, 2008)
  - Assignments, assessments, and outcomes must align (Haynes et al., 2016)
### Objective Three: Results

#### Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Std. Error</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.86</td>
<td>14.87</td>
</tr>
<tr>
<td>Female</td>
<td>0.51</td>
<td>16.91</td>
</tr>
</tbody>
</table>

No Significance Found
# Objective Three: Results

Gender within Grade Level

<table>
<thead>
<tr>
<th>Level and Gender</th>
<th>Mean</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, Freshman</td>
<td>14*</td>
<td>1.34</td>
</tr>
<tr>
<td>Male, Senior</td>
<td>16</td>
<td>1.30</td>
</tr>
<tr>
<td>Female, Freshman</td>
<td>15.72</td>
<td>0.76</td>
</tr>
<tr>
<td>Female, Senior</td>
<td>17.88*</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Note: Significant at \(*p<.05\)
Objective Three: Conclusions

- No difference within gender for critical thinking skills
- There is a difference between freshmen males and senior females
Objective Three: Recommendations

- No further research needed for gender based study in critical thinking skills

- Focus on other demographics in future studies
Impact on Animal Science Curriculum

- Importance of the studies:
  - Most employers (75%) want colleges to put an emphasis on critical thinking skills
  - According to employers they want their employees to have learned critical thinking skills in school not in the industry
    (Scanlon, Bruening, & Cordero, 1996; AACU, 2013)

- This study provides department personnel:
  - Students’ critical thinking skills
  - Provides base knowledge for further research
Further Research

- Analysis on the specific teaching techniques and assessments tools being utilized in the curriculum for alignments and effectiveness

- Research the alignment of the courses and goals and outcomes of the curriculum

- Implement follow up assessments for continuous collaboration between courses to ensure the courses are building upon one another
Questions?
References


References


- Skaar, B. (2013) Report provided to College of Agriculture and Life Sciences Curriculum Assessment Committee. (Available from the Department of Animal Science at Iowa State University, 1221 Kildee Hall, Ames, IA, 50010.)
