Engaging Faculty in Assessing Critical Thinking Using the CAT Instrument

Barry Stein, Professor, Co-Director
Ada Haynes, Professor, Co-Director
Kevin Harris, Associate Director

Center for Assessment and Improvement of Learning

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Workshop Goals

- Give institutions hands-on experience with the CAT instrument.
- Explore how the CAT can be used to encourage more effective practices within disciplines.
- Discuss potential ways to use the CAT for assessment.
Workshop Materials

Yours to Keep

- Training Manual
- Technical Information
- Overview CD
- Sample Institutional Reports

Secure Items (not to be taken)

- CAT Test with Sample Responses
- Scoring Guide
National Advisory Board

Dr. John Bransford  
James W. Mifflin University Professor  University of Washington

Dr. Donald Deeds  
Professor of Biology  Drury University

Dr. Peter Ewell  
Vice President  The National Center for Higher Education Management Systems

Dr. Michael Grant  
Associate Vice Chancellor  University of Colorado

Dr. Gregory Light  
Director Searle Center for Teaching Excellence – Northwestern

Dr. Patricia Turner  
Vice Provost Univ. California Davis & Director Reinvention Center
Importance of Critical Thinking

National polls indicate over 90% of the faculty in this country think critical thinking is the most important part of undergraduate education.

Derek Bok, 2005
President Emeritus of Harvard University
Importance of Critical Thinking

Explosion of Information

Internet

E=MC²
Email
MySpace
Wikipedia
Facebook
Phone Apps
Augmented Reality
MOOCs
Blogs
Television
Radio
Books
Magazines
Journals
The Changing Nature of Education

Remembering Information

Finding Relevant Information
Understanding & Evaluating Information
Using Information Effectively
Where Do We Get Information

75% of College Students use the Internet as Primary Method of Searching for Information

People are more likely to believe something on YouTube than from the CDC

59% of Adults Use the Internet for Healthcare Information
What is Critical Thinking?

Classic Emphasis

Evaluate Arguments and Conclusions

Reasoning
What is Critical Thinking?

Classical Emphasis

Evaluate Arguments and Conclusions

Reasoning

Expanded Contemporary Emphasis

Evaluate Ideas and Plans

Problem Solving

Communication

Evaluate One’s Own Understanding

Life-Long Learning Skills

Creativity
Bloom’s Classic Taxonomy

- Evaluation
- Synthesis
- Analysis
- Application
- Comprehension
- Information (rote retention)

Critical Thinking
Agreement on what is **not** Critical Thinking

<table>
<thead>
<tr>
<th>*NSSE Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2a) Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form.</td>
</tr>
</tbody>
</table>

*National Survey of Student Engagement*, Indiana University
NSSE: Coursework emphasizes: Memorizing facts, ideas, or methods from your courses and readings

Student Responses Nationally

- Very little: 10%
- Some: 30%
- Quite a bit: 35%
- Very much: 25%
Why Assess Critical Thinking?

- Need to Measure Success for Accountability
- Assessment Drives Improvement Efforts
- How We Assess - Determines What Students Learn
History of CAT Development

Preliminary Work At TTU 2000 - 2004

Collaborate With Other Institutions To Refine CAT 2004 - 2007

Develop Training Methods for National Dissemination & Collect Norms 2007 - 2010

Expand National Dissemination & Support Assessment in NSF Projects 2010 - 2014
Over 150 Institutions Collaborating
Designing the CAT Instrument

- **Faculty Driven:** High Face Validity Involved in Scoring
- **Construct Validity:** Learning Sciences
- **Engaging for Students**
- **Reliable & Consistent Scoring Essay Responses**
Skills Evaluated by CAT Instrument

**Evaluating Information**
- Separate factual information from inferences.
- Interpret numerical relationships in graphs.
- Understand the limitations of correlational data.
- Evaluate evidence and identify inappropriate conclusions.

**Creative Thinking**
- Identify alternative interpretations for data or observations.
- Identify new information that might support or contradict a hypothesis.
- Explain how new information can change a problem.

**Learning & Problem Solving**
- Separate relevant from irrelevant information.
- Integrate information to solve problems.
- Learn & apply new information.
- Use mathematical skills to solve real-world problems.

**Communication**
- Communicate ideas effectively.
# CAT Statistics

<table>
<thead>
<tr>
<th></th>
<th>ACT</th>
<th>SAT</th>
<th>Academic Profile</th>
<th>Grade Point Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAT</strong></td>
<td>0.501*</td>
<td>0.516*</td>
<td>0.562*</td>
<td>0.295*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>CCTST</strong> (California Critical Thinking Skills Tests)</th>
<th><strong>CAAP Critical Thinking Module</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAT</strong></td>
<td>0.645*</td>
<td>0.691*</td>
</tr>
</tbody>
</table>
### CAT Results with 2005 NSSE
(National Survey of Student Engagement)
Multiple $R = .490$
(explains 24% of variability in CAT)

<table>
<thead>
<tr>
<th>NSSE Question</th>
<th>Beta Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2a) Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form. <em>(negative relationship)</em></td>
<td>(-.341^{**})</td>
</tr>
<tr>
<td>(3b) Number of books read on your own (not assigned) for personal enjoyment or academic enrichment.</td>
<td>(.277^{**})</td>
</tr>
<tr>
<td>(11e) Thinking critically and analytically &amp; (11m) Solving complex real-world problems</td>
<td>(.244^{**})</td>
</tr>
<tr>
<td>(7h) Culminating Senior Experience (thesis, capstone course, project, comprehensive exam, etc.)</td>
<td>(.231^{*})</td>
</tr>
</tbody>
</table>

* Significant at .01 level  
** Significant at .001 level
CAT features

- One hour exam
- Mostly short answer essay
- Faculty scored in workshops
- Detailed scoring guide
- Sensitive to course effects
- Reliable
- Valid
A scientist working at a government agency believes that an ingredient commonly used in bread causes criminal behavior. To support his theory the scientist notes the following evidence.

- 99.9% of the people who committed crimes consumed bread prior to committing crimes.
- Crime rates are extremely low in areas where bread is not consumed.

Do the data presented by the scientist strongly support their theory? Yes ___ No____

Are there other explanations for the data besides the scientist’s theory? If so, describe.

_____________________________________________________________________________

What kind of additional information or evidence would support the scientist’s theory?

_____________________________________________________________________________
Ensuring Reliability of Scoring

- Detailed Scoring Guide
- Integrated Training/Scoring
- Train-the-Trainer Workshops
- Multiple Scorers Each Question
- Scoring Calibration
Mini-workshop vs. Standard Training

**Mini-workshop**

- Examine Sample Student Responses
- Use Scoring Guide

**Standard Train-the-Trainer Workshop**

- Score Real Student Tests
- Use Scoring Guide
- Use Multiple Scorers
- Deal with Ambiguous Responses
CAT Test with Sample Student Responses
Effective Practices Are A Moving Target

Video
Closing the Loop in Assessment and Quality Improvement

Ability to Transfer CT Skills Beyond Discipline
Assess Student Performance

Improve Student Learning

Increase Faculty Awareness of Effective Practices
and How to Design Better Discipline Specific Assessments
Professional Development: Faculty Involvement in CAT Scoring

- Identify Student Weaknesses
- Recognize Faculty Strengths & Weaknesses

Develop a Teaching Community

Use Effective Practices
Design a task that resembles what we want students to do.

- Engage Students In Active Learning
- Learning Activity = Real-World Goal
- Create Numerous Opportunities to Practice In Diverse Contexts
- Use as Primary Course Assessment
Skill Set 1: Encouraging Effective Course Assessments

Provide alternative interpretations for information or observations that have several possible interpretations.

Identify additional information or evidence needed to evaluate the alternative interpretations.

Patterns of Data  Historical Events  Literature
### Skill Set 2: Encouraging Effective Course Assessments

- Separate relevant from irrelevant information when searching for information to solve a real-world problem.
- Identify and explain the best solution for a real-world problem using relevant information.
- Explain how changes to a real-world problem situation might alter the recommended solution.

**Selecting New Lab Equipment**

**Solving a Community Problem – Feral Cats**

**Designing a Set For a Play**
What Are We Learning From National Use of the CAT

Faculty Involvement is Beneficial

Faculty Can Improve Course Assessments

Strategies for Improving Critical Thinking
Examples of Effective Practices for Teaching Critical Thinking

- Real World Problems
- Service Learning
- Original Research
- Case Studies
- Debates
- Simulations
SUCCESSFUL PROJECTS

Some Examples of Projects that have Improved CAT Scores

Clemson University

NSF TUES (CCLI) Project #0837540. Development of an Inquiry-Based Cell Biology Laboratory with Emphasis on Scientific Communication Skills. PI: Dr. Lesly Temesvari (LTemesv@clemson.edu) or Dr. Terri Bruce (terri@clemson.edu).

This project involved the development of a new cell biology laboratory course that emphasized critical thinking, effective writing and communication, and ethical reasoning. The new course used an inquiry-based pedagogic strategy allowing students to design and perform experiments in the context of mini research projects. Students also gained experience in communicating their findings through poster/oral presentations and through the writing of manuscripts in standard journal format. As a part of the scientific inquiry and communication processes, students also engaged in the discussion of the ethics of scientific communication.

Duquesne University

NSF TUES (CCLI) Project #717685. A Model for Incorporating Application-Based Service Learning in the Undergraduate Science Curriculum. Dr. Nancy Trun (PI) trun@duq.edu, Dr. Lisa Ludvico & Dr. Becky Morrow (Co-PIs).

http://www.scienceresearch.duq.edu/bio/biofac/ntrun/ABSL/index.html

Application Based Service Learning (ABSL) is a pedagogy that we are developing to address the need for novel approaches to Science, Technology, Engineering and Math (STEM) education at the undergraduate level. ABSL combines traditional service learning with novel undergraduate research
Various CT Assessments

- CAT
  - Portfolios, Rubrics, & other Tests
    - (CLA, CCTST, CAAP CT module)
- IDEA Teaching Evaluations
  - NSSE/CSSE & other surveys
- Alumni & Employer surveys

Student Performance

Student Perceptions

Alumni/Employer Perceptions
Assessment Uses of CAT

Informal Learning Experiences

Classroom Learning Experiences

Program Outcomes

College Outcomes

Value Added Enter vs. Exit

Tracking Outcomes Over Time

Norm Referenced
CAT Institutional Reports

Sample Report
Page # 31 of Manual
### Student Information

**Answer Selection:** Correct = ✓ Incorrect = ✗

<table>
<thead>
<tr>
<th>Student ID Number</th>
<th>What is your Age?</th>
<th>Local Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **What is your gender?**  
   *Select One.*
   - ✓  
   - ✗

   **Note:** Please answer BOTH Questions 2 and 3.

2. **Are you Spanish/Hispanic/Latino?**  
   *Select One.*
   - ✓  
   - ✗

3. **What is your race?**  
   *Select one or more categories to indicate your race (from U.S. Census Categories).*
   - White
   - Asian
   - Black or African American
   - Native Hawaiian or Other Pacific Islander
   - American Indian or Alaska Native
   - Other race

4. **Do you consider English your primary language?**  
   *Select One.*
   - ✓  
   - ✗

5. **Rate your proficiency with the English Language.**  
   *Select level of proficiency.*

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

6. **What is your class standing?**
   - ✓  
   - ✗

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Sophomore</th>
<th>Junior</th>
<th>Senior</th>
<th>Undergraduate</th>
<th>Graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. **Undergraduate or Graduate?**
   - ✓  
   - ✗

<table>
<thead>
<tr>
<th>Undergraduate</th>
<th>Graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
CAT Overview: Descriptive Statistics for CAT Total Score
Sample Institution: Date 2010

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT Total Score</td>
<td>69</td>
<td>11.00</td>
<td>36.00</td>
<td>24.32</td>
<td>5.02</td>
</tr>
</tbody>
</table>

Average Total Points Attained

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
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<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>6</td>
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<td>12</td>
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<td>14</td>
</tr>
<tr>
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<tr>
<td></td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>38</td>
</tr>
</tbody>
</table>

CAT Demographics: Descriptive Statistics for Sample

<table>
<thead>
<tr>
<th>Gender</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>48</td>
<td>48.5%</td>
</tr>
<tr>
<td>Female</td>
<td>51</td>
<td>51.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class Standing</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>36</td>
<td>38.7%</td>
</tr>
<tr>
<td>Sophomore</td>
<td>31</td>
<td>33.9%</td>
</tr>
<tr>
<td>Junior</td>
<td>16</td>
<td>18.3%</td>
</tr>
<tr>
<td>Senior</td>
<td>15</td>
<td>17.3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Graduate</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-20 years</td>
<td>72</td>
<td>72.7%</td>
</tr>
<tr>
<td>21-25 years</td>
<td>28</td>
<td>28.3%</td>
</tr>
<tr>
<td>≥26 years</td>
<td>1</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proficiency with the English Language*</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>71</td>
<td>72.2%</td>
</tr>
<tr>
<td>Very Good</td>
<td>17</td>
<td>17.5%</td>
</tr>
<tr>
<td>Good</td>
<td>9</td>
<td>9.3%</td>
</tr>
<tr>
<td>Fair</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Race**</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>61</td>
<td>61.6%</td>
</tr>
<tr>
<td>Black or African American</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Asian</td>
<td>29</td>
<td>29.3%</td>
</tr>
<tr>
<td>Native Hawaiian or Other Pacific Islander</td>
<td>1</td>
<td>1.0%</td>
</tr>
<tr>
<td>Other Race</td>
<td>1</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spanish/Hispanic/Latino Ethnicity</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish/Hispanic/Latino Ethnicity</td>
<td>5</td>
<td>5.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Considered English primary language?</th>
<th>Freq</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Considered English primary language?</td>
<td>88</td>
<td>88.9%</td>
</tr>
</tbody>
</table>

* Self-rated
** The cumulative percent may exceed 100% as students are allowed to select more than one category.
<table>
<thead>
<tr>
<th>Evaluate and Interpret Info</th>
<th>Problem Solving</th>
<th>Creative Thinking</th>
<th>Effective Comm.</th>
<th>Skill Assessed by CAT Question</th>
<th>Pre Mean</th>
<th>Post Mean</th>
<th>Probability of difference&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Effect Size&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q1</td>
<td>Summarize the pattern of results in a graph without making inappropriate inferences.</td>
<td>.46</td>
<td>.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q2</td>
<td>Evaluate how strongly correlational-type data supports a hypothesis.</td>
<td>.39</td>
<td>.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q3</td>
<td>Provide alternative explanations for a pattern of results that has many possible causes.</td>
<td>.79</td>
<td>1.37</td>
<td>*</td>
<td>+.58</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q4</td>
<td>Identify additional information needed to evaluate a hypothesis.</td>
<td>.81</td>
<td>1.46</td>
<td>**</td>
<td>+.78</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q5</td>
<td>Evaluate whether spurious information strongly supports a hypothesis.</td>
<td>.58</td>
<td>.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q6</td>
<td>Provide alternative explanations for spurious associations.</td>
<td>.91</td>
<td>1.30</td>
<td>*</td>
<td>+.46</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q7</td>
<td>Identify additional information needed to evaluate a hypothesis.</td>
<td>.58</td>
<td>1.00</td>
<td>**</td>
<td>+.68</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q8</td>
<td>Determine whether an invited inference is supported by specific information.</td>
<td>.45</td>
<td>.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q9</td>
<td>Provide relevant alternative interpretations for a specific set of results.</td>
<td>.70</td>
<td>1.12</td>
<td>*</td>
<td>+.55</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q10</td>
<td>Separate relevant from irrelevant information when solving a real-world problem.</td>
<td>3.39</td>
<td>3.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q11</td>
<td>Use and apply relevant information to evaluate a problem.</td>
<td>1.15</td>
<td>1.21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q12</td>
<td>Use basic mathematical skills to help solve a real-world problem.</td>
<td>.79</td>
<td>.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q13</td>
<td>Identify suitable solutions for a real-world problem using relevant information.</td>
<td>.86</td>
<td>.67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q14</td>
<td>Identify and explain the best solution for a real-world problem using relevant information.</td>
<td>1.30</td>
<td>1.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
<td>Q15</td>
<td>Explain how changes in a real-world problem situation might affect the solution.</td>
<td>.30</td>
<td>.82</td>
<td>**</td>
<td>+.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>CAT Total Score</strong></td>
<td>13.51</td>
<td>16.33</td>
<td>***</td>
<td>+.55</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> * p < .05  ** p < .01  *** p < .001 (2–tailed)

<sup>b</sup> Mean difference divided by pooled group standard deviation.

(0.1 - 0.3 = small effect; 0.3 - 0.5 = moderate effect; >0.5 = large effect)

The map of skills covered by each question above is a suggested theoretical guide for interpreting results.

Center for Assessment & Improvement of Learning © 2007, 2010
National Dissemination Model

Institution
8 – 14 Faculty Involved in Scoring

2 - 3 Representatives

CAT Regional Training
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