Assessing Critical Thinking Using the CAT Instrument

Dr. Barry Stein, PI, Director of Planning    Dr. Ada Haynes CoPI, QEP Director
Kevin Harris, Assist. Dir. of Assessment

Center for Assessment and Improvement of Learning

ABET Best Assessment Processes Symposium, 2009

Partial support for this work was provided by the National Science Foundation’s CCLI Program under grants 0404911, 0717654.

© Tennessee Tech University 2009
Disclaimers

1. ABET does not endorse the use of this or any other specific test.

2. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.
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
CAT Workshop

- 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

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

Secure Items (not to be taken)

- CAT Test with Sample Responses
- Scoring Guide
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
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
- Evaluate One’s Own Understanding
  - Life-Long Learning Skills
- Evaluate One’s Own Understanding
  - Communication
  - Creativity

Life-Long Learning Skills

Communication

Creativity
Bloom’s Taxonomy

Evaluation
Synthesis
Analysis
Application
Comprehension

Information (rote retention)

Critical Thinking
Agreement on what is not Critical Thinking

*NSSE Question

(2a) Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form.

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

Need to Measure Success for Accountability

Assessment Drives Improvement Efforts
History of CAT Development

Evaluate Tests

Begin Test Development

Collaborate with Other Institutions

National Dissemination

[Diagram showing the steps of CAT Development: Evaluate Tests, Begin Test Development, Collaborate with Other Institutions, National Dissemination]
Institutions Participating in Test Development

- Howard University
- Madisonville Community College
- The University of Colorado
- The University of Hawaii
- The University of Southern Maine
- The University of Texas
- The University of Washington
Developing the CAT Instrument

Faculty & Students

Learning Sciences Experts

CAT

External Evaluators

Statistical Findings
Skills Evaluated by CAT Instrument

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

**Evaluating Ideas/Other Points of View**
- Identify & evaluate evidence for a theory.
- 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.
Percent of Faculty that Identify Areas Targeted by CAT as Important Components of Critical Thinking

- Separate facts from inferences
- Identify/inappropriate conclusions
- Understand limitations of correlations
- Identify evidence to evaluate hypotheses
- Identify/information needed for conclusions
- Separate relevant from irrelevant information
- Learn and apply new information
- Interpret numerical relationships in graphs
- Use mathematical skills to solve a problem
- Integrate information to solve problems
- Explain how new information can change a problem
- Communicate ideas effectively
## CAT Statistics

### General Measures of Academic Performance

<table>
<thead>
<tr>
<th>ACT</th>
<th>SAT</th>
<th>Academic Profile</th>
<th>Grade Point Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>0.599*</td>
<td>0.527*</td>
<td>0.345*</td>
</tr>
</tbody>
</table>

* correlations significant, $p < .01$

### Other Measures of Critical Thinking

<table>
<thead>
<tr>
<th>CCTST (California Critical Thinking Skills Tests)</th>
<th>CAAP Critical Thinking Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 0.645*</td>
<td>0.691*</td>
</tr>
</tbody>
</table>

* correlations significant, $p < .01$
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
- Reliable (0.82 - 0.85)
- Valid
Sample Disclosed Question

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?

____________________________________________________________________
Student Comments

• I thought the test wasn’t too difficult, but it was challenging. You have to look at things deeply to truly understand.

• I thought the assessment was interesting and made me use real life scenarios and data to decide my results.

• I thought the test was thought provoking, but not too difficult.

• It was an easy test that tests the mind. I enjoyed the stories and the questions on the test. I think I did very well on the test.
Ensuring Reliability of Scoring

- Detailed Scoring Guide
- Integrated Training/Scoring
- Multiple Scorers Each Question
- Train-the-Trainer Workshops
- 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
Closing the Loop in Assessment and Quality Improvement

Assess Student Performance

Improve Student Learning

Increase Faculty Awareness of Student Weaknesses (Faculty Participate in Test Scoring)

Increase Faculty Awareness of Effective Practices
Professional Development: Faculty Involvement in CAT Scoring

Developing a Teaching Community

Using Effective Practices

Identify Student Weaknesses

Recognize Faculty Strengths & Weaknesses
Design a task that resembles what we want students to do.

- Must Engage Students In Active Learning
- Learning Activity = Real-World Goal
- Create Numerous Opportunities to Practice In Diverse Contexts
- Use as Primary Course Assessment
Designing Discipline Specific Analogs
Various CT Assessments

- **CAT**
  - Portfolios, Rubrics & Other Tests (CLA, CCTST, CAAP CT module)
  - Student Performance

- IDEA Teaching Evaluations
  - NSSE/CSSE & other surveys
  - Student Perceptions

- Alumni & Employer surveys
  - 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
## Designing an Assessment Plan Using the CAT Instrument

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test vs. Post-test</td>
<td>Course</td>
<td></td>
<td>Students show more improvement from the pre-test to the post-test than the control group</td>
<td>expense</td>
<td></td>
</tr>
<tr>
<td>with Control Group (in course or program)</td>
<td>Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test vs. Post-test</td>
<td>Course</td>
<td></td>
<td>Students show improvement from the pre-test to the post-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(in course or program)</td>
<td>Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More Expensive</td>
<td>Freshmen vs. Upperclassmen (value added)</td>
<td></td>
<td>Students show significant gains from freshmen year to senior year</td>
<td>Attrition, expense, time</td>
<td></td>
</tr>
<tr>
<td>Track same students over time</td>
<td>Freshmen &amp; Upperclassmen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshmen vs. Upperclassmen (value added)</td>
<td>Freshmen &amp; Upperclassmen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-sectional study (must equate groups)</td>
<td>Freshmen &amp; Upperclassmen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less Expensive</td>
<td>Track Institutional Progress over time</td>
<td></td>
<td>Institution scores improve over time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upperclassmen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less Expensive</td>
<td>Track Institutional Progress over time with National Norm Comparison</td>
<td></td>
<td>Institution scores improve over time and/or surpass national norms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upperclassmen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Next Steps for Institutions Interested in Using the CAT

- Assessment Plan
- Train-the-Trainer Workshop
  - Who will you send (2-3 people)
  - New England – Fall semester
- Ordering Tests
- Processing Tests
CAT National Dissemination Project

www.tntech.edu/CAT
or
www.CriticalThinkingTest.org

Center for Assessment and Improvement of Learning

Tennessee Tech University