What the CAT Offers for Assessment: Engaging Faculty in Assessing & Improving Critical Thinking Skills

Barry Stein, Professor, Co-Director   Ada Haynes, Professor, Co-Director
Tennessee Tech University

Meg Skinner, ECTL Director   Erika Prager, Assessment Specialist
University of Wyoming

Reinvention Center, 2012

Partial support for this work was provided by the National Science Foundation’s TUES Program under grant 1022789.

© Tennessee Tech University & University of Wyoming 2012
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
Workshop Goals

- Background Information on the CAT and Changing Nature of Education
- Advantages of Faculty Involvement in Scoring
- University of Wyoming Experience Using the CAT
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=MC\(^2\), Email, MySpace, Television, Blog, Wikipedia, Facebook, Phone Apps, Augmented Reality, 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
Creativity

Evaluate One’s Own Understanding
Life-Long Learning Skills
Bloom’s Classic 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

Video
NSSE: Coursework emphasizes: Memorizing facts, ideas, or methods from your courses and readings

Student Responses Nationally

- Very little: 5%
- Some: 30%
- Quite a bit: 35%
- Very much: 20%
Why Focus on Assessing 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.
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?

__________________________________________________________________________
Faculty Development Using the CAT

Closing the Loop in Assessment and Quality Improvement

Assess Student Performance

Improve Student Learning

Increase Faculty Awareness of Best Practices

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

© Tennessee Technological University
Examples of Effective Practices for Teaching Critical Thinking

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

<table>
<thead>
<tr>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate relevant from irrelevant information when searching for information to solve a real-world problem.</td>
</tr>
<tr>
<td>Identify and explain the best solution for a real-world problem using relevant information.</td>
</tr>
<tr>
<td>Explain how changes to a real-world problem situation might alter the recommended solution.</td>
</tr>
</tbody>
</table>

- 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
- Strategies for Improving Critical Thinking
- Faculty Can Improve Course Assessments
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 Ternesvari (LTENSY@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@dug.edu, Dr. Lisa Ludvico & Dr. Becky Morrow (Co-PIs).
http://www.scienceresearch.dug.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.
University of Wyoming
Experience Using the CAT
Looking for a tool to assess critical thinking, which is one of the program's identified student learning outcomes
Institutional Look at CAT

- 90% of UW depts/programs have a student learning outcome related to higher order thinking skills
  - Critical thinking, problem-solving, analytic reasoning

- Revision of UW’s USP Program – Critical thinking skills are specifically identified
  - Critical and creative thinking
  - Inquiry and analysis
  - Problem-solving
What We Initially Liked About the CAT

- Developed by and scored by faculty
- A clear definition of critical and creative thinking
- Flexibility in its use (e.g. program assessment)
- Administered in one hour class
- Tennessee Tech's Center for Assessment & Improvement of Learning responsive to UW's needs
- Reasonable costs - keep our money in-house
UW’s CAT Projects

- 4 departments/programs used CAT in 2011-12:
  - School of Pharmacy
  - Division of Social Work
  - Department of Veterinary Sciences
  - College of Business

- Additional programs using CAT in 2012-13:
  - Department of Geology and Science Math Teaching Center
  - UW Assessment Academy (Physiology, Kinesiology, Nursing)
School of Pharmacy

- 3 year plan (Aug 2011-May 2014)
- P1s (incoming students) tested in fall of each year
- P3s (entering clinicals) and P4s (graduating) tested in spring of each year
- Cross-sectional and longitudinal study
- Use CAT results to predict likelihood of success in program
  - Past performance (ACT/SAT and PCAT)
  - Academic performance at UW (GPA, grades in specific courses, etc.)
Division of Social Work

- BSW students
  - 2 cohorts of entering students - Laramie and UW/Casper College (45 students)
  - Want to see if there is a difference in cohort performance

- MSW students
  - Skill level of new graduate students entering without BSW degree compared to performance after first year (16 students)
  - CAT administered during class and discussed in context of skills needed to be a successful social worker
Veterinary Sciences

- Cross-sectional study (first-year students compared to upper-division students)
  - PATB 1001 (Freshman Interest Group)
  - PATB 4710 (Virology)
  - 64 students total
- Fall semester
College of Business

- Pilot project (spring 2012)
  - Assess critical thinking skills of graduating students
  - College of Business capstone course (MGMT 4800)
  - Administered outside class to volunteers (paid $25)
  - Goal was to test 100 of 200 students; 37 students tested

- Revised plan (2012-13)
  - Cross-sectional and longitudinal study (freshmen vs. senior performance)
  - Test 240 freshmen in ACCT 1010 in fall semester
  - Test 240 seniors in MGMT 4800 in spring semester
  - Follow freshmen through program
What We Learned So Far About Critical Thinking

- Wide range of results
  - By program/student major
  - By level of students
  - By CAT questions
Pharmacy

- Highest overall scores at UW
- Scored above national average
- P4s performed the best; P1s performed better than P3s
- Stat differences (positive) for 7/15 questions for P1s
- Stat differences (2 pos/1 neg) for 3/15 questions for P3s
- Stat differences (11 pos/1 neg) for 12/15 questions for P4s
- Negative difference for both cohorts - Using an applying relevant information to evaluate a problem (Q 11)
Social Work

- Graduate students scored higher, but both scored below national average
- No differences between Laramie and Casper cohorts
- Stat differences (pos) for 1/15 questions for grad students
- Stat differences (neg) for 4/15 questions for undergrads
- Still looking for patterns in data
  - High percentage could use basic mathematic skills to help solve a real world problem (Q 12)
  - Undergraduates scored below average and graduates above average - Providing alternative explanation for a pattern of results that has many possible causes (Q 3)
Veterinary Sciences

- Upper and lower division students scored well above the national average
- Stat differences (positive) for 5/15 questions for students in PATB 4710
- Stat differences (positive) for 3/15 questions for students in PATB 1001
- Both groups were above average for providing alternative explanations for spurious associations (Q 6)
Graduating seniors scored just above national average

Stat difference (negative) for 1/15 questions
- Using and applying relevant information to evaluate a problem (Q 11)
Faculty Reactions

- CAT validated some suspicions regarding the lack of specific critical thinking skills
- Provided insight on how to deal with ambiguous student responses in class
- Increased validity of open book tests
- Challenged the way some faculty currently structure test questions (e.g. recall vs. critical thinking)
- Rethinking their own grading rubrics - simplifying them
- Assessment can actually be fun!
Perceived Benefits of Using the CAT

- Multiple and different opportunities to engage faculty
  - Groups/depts/program and individually
  - Reluctant faculty to the assessment table
- Faculty become your best advocates
- Provides anchor to institutional programming on critical thinking
- It is easier to administer and facilitate compared to other standardized assessments
  - Logistics
  - $
Engaging Faculty in the Assessment and Improvement of Students’ Critical Thinking Using the CAT

New Challenges, New Strategies
Building Excellence in Undergraduate STEM Education

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.