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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
Information and the Internet

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

31% of Population Use the Internet as Primary Source of Healthcare Information

Factual Error Found On Internet

LONGMONT, CO—The Information Age was dealt a stunning blow Monday, when a factual error was discovered on the Internet. The error was found on Ted's Ultimate Brady Bunch, a fan site for the show's debut year as 1968, not 1969.

Caryn Wissniewski, a Pueblo, CO, legal secretary and diehard Brady Bunch fan, came across the mistake while searching for information about the show's first-season cast.

"When I first saw 1968 on the web page, I thought, 'Wow, apparently, all those Brady Bunch books I've read listing 1969 as the show's first year were wrong.'" Wissniewski told reporters at a press conference. "But even though I obviously trusted the Internet, I was still kind of puzzled. So I checked other Brady Bunch fan sites, and all of them said 1969. After a while, it slowly began to sink in that the World Wide Web might be tainted with unreliable information."

Following up on her suspicion, Wissniewski phoned her public library, the ABC television network, and the office of Brady Bunch producer Sherwood Schwartz—all of whom confirmed that "Ted's Ultimate Brady Bunch Site" was in error.

Attempts to contact the webmaster of the site proved fruitless.

31% of Population Use the Internet as Primary Source of 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

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
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%

*Chart showing the percentage of students' responses to the emphasis on memorization.*
Why Assess Critical Thinking?

Need to Measure Success for Accountability

Assessment Drives Improvement Efforts

How We Assess - Determines What Students Learn
Designing the CAT Instrument

- **Faculty Driven:** High Face Validity Involved in Scoring
- **Construct Validity:** Learning Sciences
- **Engaging for Students**
- **Reliable & Consistent Scoring Essay Responses**
History of CAT Development

**Preliminary Work At TTU**
2000 - 2004

**NSF**

**Collaborate With Other Institutions To Refine CAT**
2004 - 2007

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

**NSF**

**Expand National Dissemination & Support Assessment in NSF Projects**
2010 - 2014
Over 70 Institutions Collaborating
Faculty Evaluations of Question Validity

![Bar chart showing faculty evaluations of question validity over different years. The x-axis represents the years (2014 to 2016), and the y-axis represents the percent. The bars are uniformly high, indicating a high level of validity across all years.](chart.png)
# CAT Statistics

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

<table>
<thead>
<tr>
<th>CAT</th>
<th>CCTST (California Critical Thinking Skills Tests)</th>
<th>CAAP Critical Thinking Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>0.645*</td>
<td>0.691*</td>
</tr>
</tbody>
</table>
## CAT Results with 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</td>
<td>-.341 **</td>
</tr>
<tr>
<td>you can repeat them in pretty much the same form. <em>(negative relationship)</em></td>
<td></td>
</tr>
<tr>
<td>(3b) Number of books read on your own (not assigned) for personal enjoyment</td>
<td>.277 **</td>
</tr>
<tr>
<td>or academic enrichment.</td>
<td></td>
</tr>
<tr>
<td>(11e) Thinking critically and analytically &amp; (11m) Solving complex real-world</td>
<td>.244 **</td>
</tr>
<tr>
<td>problems</td>
<td></td>
</tr>
<tr>
<td>(7h) Culminating Senior Experience (thesis, capstone course, project,</td>
<td>.231 *</td>
</tr>
<tr>
<td>comprehensive exam, etc.)</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at .01 level
** Significant at .001 level
CAT Instrument Sensitive to Class Standing & Individual Courses
CAT features

- One hour exam
- Mostly short answer essay
- Faculty scored in workshops
- Detailed scoring guide
- Reliable
- Valid

Cost

$5 Test, $200 Year Participation Fee
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
- Multiple Scorers Each Question
- Train-the-Trainer Workshops
- Scoring Calibration
Scoring Accuracy:
Other Institutions – TTU rescore
Assessment Uses of CAT

- Informal Learning Experiences
- Classroom Learning Experiences
- Program Outcomes
- College Outcomes
- Norm Referenced
- Tracking Outcomes Over Time
- Value Added
  - Enter vs. Exit

The diagram illustrates the various uses of CAT in assessment, including informal and classroom learning experiences, program outcomes, college outcomes, and norm referenced tracking over time, leading to value added measures.
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

Identify Student Weaknesses

Developing a Teaching Community

Recognize Faculty Strengths & Weaknesses

Using Effective Practices
Effective Practices

Student Centered
Knowledge Centered
Assessment Centered
Community Centered
General Implications

- Learning for Rote Retention ≠ Problem Solving/Transfer
- Prior Knowledge can Impede or Facilitate Learning
- Transfer is Difficult – Requires Active Learning in Varied Contexts with Reflection
- Assessments Measure Certain Types of Learning but also Establish Expectations
Relationship Between Assessment & Learning Strategy Selection

Student

Transfer Strategy

Retention Strategy

Real Goal?

Factual Knowledge Test
SkillsEvaluatedbyCATInstrument

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

**CreativeThinking**
- 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&ProblemSolving**
- 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.
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 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.

Sam Houston State University

A multidisciplinary general education course, Foundations of Science, was developed to improve students’ critical thinking and scientific literacy. The course is taught collaboratively by faculty in Geography/Geology and Biology. Marcus Gillespie [GEO_BMG@SHSU.EDU], Matthew Rowe [MPRO092@SHSU.EDU]

In the course, students critically evaluate a diversity of extraordinary and engaging claims (sometimes controversial), ranging from astrology to alternative medicines to the lost continent of Atlantis to help them understand the relevance of science in their daily lives. Students work in groups to discuss various Case Studies (many designed specifically for this course). The course emphasizes the way scientists think critically about information and ideas more than the facts of science. The course also incorporates discussion of common logical fallacies, and other types of reasoning/perceptual biases that can mislead us. Students are introduced to the importance of sample size, double-blind clinical studies, and the placebo effect during our discussions of alternative medicines and alleged paranormal phenomena. Throughout the course, we try to help students understand that they can use what they learn about science and critical thinking to help them make better decisions for themselves, for their families, and for society.

University of Wisconsin - Madison

NSF CCLI Project #0737352. Teaching nature of science and scientific inquiry in the context of scientific paradigms - Assessing student understanding: Bassi Tiko'off (PI) & Nancy Ruggeri, basst@geology.wisc.edu

Excerpt from Course Description: This course is about how scientists figure things out. To put it more formally, it is about how people make sense of the natural world in the past, understand the present, and make predictions for the future. An integral (and interesting) part of this process is the different methods scientists use to gather information and the way they communicate their ideas to others.
Motivating Faculty

- Participating in scoring session
- Establishing a faculty teaching community
- Provide small grants that provide resources for innovative practices
- Awards that include a dissemination component

“You have done so much with so little for so long that I’d like you to move on to doing everything with nothing.”
Motivating Faculty

- Provide feedback through assessment
- Help faculty understand the connection between teaching, research, external grants, and service
Center for Assessment and Improvement of Learning

Tennessee Tech University

www.CriticalThinkingTest.org

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.