Engaging Faculty in the Assessment and Improvement of Critical Thinking using the CAT Instrument

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Importance of Critical Thinking

Explosion of Information

Internet

E=MC\(^2\)
Email
MySpace
Wikipedia
Facebook
Phone Apps
Augmented Reality
Books
Magazines
Blogs
Television
Radio
Journals
Email
Facebook
MySpace
Wikipedia
Phone Apps
Augmented Reality
Books
Magazines
Blogs
Television
Radio
Journals
The Changing Nature of Education

- Remembering Information
- Understanding & Evaluating Information
- Using Information Effectively
- Finding Relevant 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
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

CAT

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 Features

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

Cost

$6 Test, $200 Year Participation Fee
National Dissemination Model

Institution
8 – 14 Faculty Involved in Scoring

2 - 3 Representatives

CAT
Regional Training
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?

________________________________________________________________________
Assessment Uses of CAT

- Informal Learning Experiences
- Classroom Learning Experiences
- Program Outcomes
- College Outcomes
Closing the Loop in Assessment and Quality Improvement

Assess Student Performance

Improve Student Learning

Increase Faculty Awareness of Effective Practices

Increase Faculty Awareness of Student Weaknesses (Faculty Participate in Test Scoring)
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/bioscience/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
Sam Houston State University’s QEP to Improve Critical Thinking

Quality Enhancement Plan

Foundations of Science: Improving Scientific Reasoning Among Non-Science Majors

Submitted By
Sam Houston State University
February, 2009

Critical Thinking Assessment Test

Scientific reasoning
General Goals

✓ improve critical thinking skills

✓ the importance of evidence and logic

✓ engender scientific habits of mind
Why Did We Choose this QEP Topic
Carnegie Institution Report

✓ > 93% of American adults are scientifically illiterate.

✓ > 78% of college graduates are scientifically illiterate.

A Twenty-Year Survey of Science Literacy Among College Undergraduates
By Chris Impey, Sondra Bass, Jessie Antinelli, Elizabeth Johnson, and Courtney King

First results from a 20-year survey of science knowledge and attitudes toward science among undergraduates are presented. The survey was conducted in 1990 and repeated in 2008. The survey covered a variety of science topics, including biology, chemistry, physics, and astronomy. The results show that the level of science literacy has improved over time, but that a significant percentage of students still struggle with basic science concepts. The survey also found that students with higher levels of science proficiency were more likely to pursue science-related careers.
Specific Course Goals

- Scientific Content & Terminology from Several Disciplines
- Enhance Critical Thinking
- Science as a *Way of Knowing*
- Distinguish Science from Pseudoscience
Pedagogies:

Case Studies & Team-based Learning
Ex: “Tragic Choices: Autism, Measles, and the MMR Vaccine”
In addition to standard science topics, we use extraordinary claims to engage the students’ attention and increase motivation...
Students Work in Groups
Groups Share Ideas
Peer Review
Why did we choose the CAT?

CAT specifically addresses scientific reasoning and it is not discipline-specific.

Students are given information in the form of scenarios and asked:

To what degree does the evidence support the conclusion?

Are there alternative interpretations/hypotheses? (MWH)

How would you test the idea? What additional evidence would you need to evaluate the claim?
Rico wanted to find out if the majority of people in Texas do not support gun control laws. So, he surveyed 25 of his friends at the local shooting range. He found that 90% of them are strongly opposed to gun control laws. Rico therefore concluded that “Texans strongly oppose gun control laws”. Which of the following is true?

a. Based on his survey results, Rico’s conclusion must be correct.
b. The sample size of Rico’s survey is appropriate.
c. The group Rico surveyed is appropriate for the purposes of determining how most Texans feel about gun control laws.

★ d. The survey Rico conducted is not adequate to support his conclusion.
e. A, B, and C are correct
Megan believes that eating corn silk from a corn plant (like that shown below) will improve the strength and luster of her hair because the corn silk looks like hair.

What logical fallacy has Meagan committed?

a. appeal to ignorance
b. post hoc ergo propter hoc (false cause)
c. faulty analogy
★ d. argument from ignorance
e. none of the above – her logic is correct
Assessing CT Gains

Pre-Test  Post-Test Design
Using CAT Instrument

Treatment vs. Control
Perspective

Gains in FoS Class => Typical Gains Over 4 Years
Benefits of use of CAT to SHSU

Graders, from multiple disciplines, have incorporated CAT-like questions into their assignments.

Grading sessions foster communication among faculty; Enjoy the sessions.

Test reveals reading comprehension and writing deficiencies.

*CAT results Validated the effectiveness of the course:*

- Led to presentations on campus focused on CT and alternative pedagogies, as well as 2 seminars.

- Course now required of all Education majors at SHSU.
Benefits beyond SHSU

- Info on CT will be presented at Correctional Management Institute of Texas seminar (CT isn’t discipline specific)

- Presentations to many universities and contacts with others

- Michigan State University: Just received $50,000 Gates Foundation grant to convert FoS course to a MOOC

Validity of CAT made these things possible
Suggestions and Lessons Learned

Give background information in PPt presentation to graders about the test and the rationale for its use at your institution.

Welcome to the CAT Grading Session

CAT = Critical thinking Assessment Test
Lessons Learned – cont’d

Keep sample size appropriate…

Limit number of graders to about 12

Repeat graders can become lax…

Try to select graders that are focused and ‘analytical’ – details matter
TTU spot checks representative sample of the tests

Can statistically correct results if the score on a question falls outside the range of acceptable variation

TTU VERY HELPFUL with any questions we’ve had
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.