Getting Faculty Involved in Assessing and Improving Students’ Critical Thinking

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Importance of Critical Thinking

Explosion of Information

Internet

E=MC²

Email

MySpace

Wikipedia

Facebook

Phone Apps

Augmented Reality

Books

Magazines

Blogs

Television

Radio

Journals

Phone Apps

Facebook

Email

MySpace

Wikipedia

E=MC²

Books

Magazines

Blogs

Television

Radio

Journals
The Changing Nature of Education

Remembering Information

Finding Relevant Information
Understanding & Evaluating Information
Using Information Effectively
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 100 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 Features

- One hour exam
- Mostly short answer essay
- Faculty scored in workshops
- Detailed scoring guide
- Sensitive to course effects
- Reliable
- Valid
National Dissemination Model

Institution
8 – 14 Faculty Involved in Scoring

2 - 3 Representatives

CAT Regional Training
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
- Value Added Enter vs. Exit
- Tracking Outcomes Over Time
- Norm Referenced
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

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

and How to Design Better Discipline Specific Assessments
SUCCESSFUL PROJECTS
Some Examples of Projects that have Improved CAT Scores

Under Construction

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 on a community problem. For the service-learning portion of the class, students spend a set number of hours throughout the semester in a specific community environment so that they learn about and understand the community problem. In class, the students conduct novel research, using the scientific method, on various parts of the community problem and investigate solutions to the problem.

Purdue University
NSF TUES (CCLI) Project #741264. An Adaptation of a Research Based Laboratory Course.
http://www.bioislanding.purdue.edu
Northwestern & City Colleges of Chicago NSF Project

Research Questions

Can we use the CAT to

1. Improve how faculty teach critical thinking?

2. Increase the gains that students make in critical thinking?
Northwestern & City Colleges of Chicago NSF Project

Present faculty with assessment data on student gains in critical thinking in their class.

To inspire them to make changes to their teaching to enhance critical thinking.

To see if changes in teaching result in greater gains in critical thinking.
Critical Thinking Initiative in STEM: Study Design

**Summer year 1**
- Faculty
  - 10 CCC & 9 NU
- CAT scoring workshop
- Develop course specific analogs

**Fall year 1**
- Measure gains on CAT & analogs over quarter/semester

**Summer year 2**
- Give faculty CAT & analog data
- Critical thinking pedagogy workshop
- Faculty develop & implement changes to teaching

**Fall year 2**
- Measure gains on CAT & analogs over quarter/semester
- Compare gains

**Engagement**
- Baseline
- Intervention
- Impact
Hypothesis

Impact on Teaching
- approaches to teaching
- approaches to assessment
- conceptions of critical thinking
- instruction

Faculty Involvement
- Scoring CAT & Course Improvement

Vs.

Standard Faculty Development Workshops
Critical Thinking Initiative in STEM: Progress

**Summer Year 1**
- Faculty: 10 CCC & 9 NU
- Developed course specific analogs

**Fall Year 1**
- Measured gains on CAT & analogs over quarter/semester
- n=241 students with pre & post course CAT tests

**Spring Year 1**
- Currently grading CAT tests & analogs

- Anatomy
- Astronomy
- Biology
- Calculus
- Chemistry
- Chemical Engineering
- Electrical Engineering
- Linguistics
- Physics
- Quantum Mechanics
Observations & Faculty Reactions

- CAT Instrument
- Analog Development
- Administering CAT in Courses
Developing Discipline Specific Analogs

Aligning Course Assessments with Critical Thinking Skills

- Identify Alternative Interpretations for Evidence
- Identify New Information Needed to Support an Idea
Researchers at the University of Alberta conducted a study of cross-linguistic differences in the realization of clear speech.

Figure 1. Total amount of time spent pausing (averaged across speakers) in clear and conversational speech in both speaker groups.
Analog Development: Discipline Specific Questions

1. Are there other possible explanations for the data in Figure 1 that do not assume that in clear speech Tlisim speakers lengthen their pauses more than English speakers? If so, explain what they are. Try to provide two alternative accounts.

2. What kind of additional information or evidence would help you evaluate the researchers’ claim? Try to provide two types of additional information.
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.