



# Engaging Faculty in Assessing Critical Thinking Using the CAT Instrument

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# Disclaimers

- The Development of the CAT Instrument and the National Dissemination of the CAT Instrument is supported by the National Science Foundation.
- 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.

# Workshop Goals

- 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

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

## Secure Items (not to be taken)

- CAT Test with Sample Responses
- Scoring Guide

# **National Advisory Board**

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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

# Importance of Critical Thinking

## Explosion of Information

### Internet



$E=MC^2$

Email

Blogs

MOOCs

Magazines

Journals

MySpace

Wikipedia

Television

Facebook

Phone Apps

Radio

Augmented Reality

Books

# The Changing Nature of Education

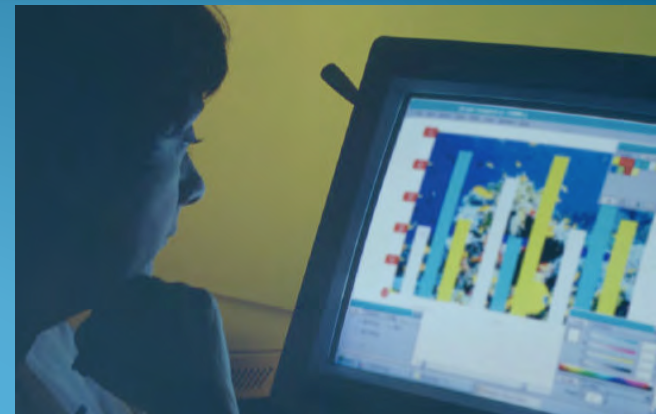
**Remembering  
Information**



**Finding Relevant Information**

**Understanding & Evaluating  
Information**

**Using Information Effectively**





# Information and the Internet

**95% of College Students use Google to Search for Information in Course-Related Research**

*People are more likely to believe something on YouTube than from the CDC*

**71% of Adults Use the Internet for Healthcare Information**

# What is Critical Thinking?

Classic Emphasis

```
graph TD; A[Classic Emphasis] --- B[Evaluate Arguments and Conclusions]; B --- C[Reasoning];
```

Evaluate Arguments and Conclusions

Reasoning

# What is Critical Thinking?

**Classical Emphasis**

**Expanded Contemporary Emphasis**



**Evaluate Arguments  
and Conclusions**

**Evaluate Ideas  
And Plans**

**Evaluate One's Own  
Understanding**

**Reasoning**

**Problem Solving**

**Life-Long Learning Skills**

**Communication**

**Creativity**

# Bloom's Classic Taxonomy

**Evaluation**

**Synthesis**

**Analysis**

**Application**

**Comprehension**

**Information (rote retention)**



Critical Thinking

# Agreement on what is not Critical Thinking

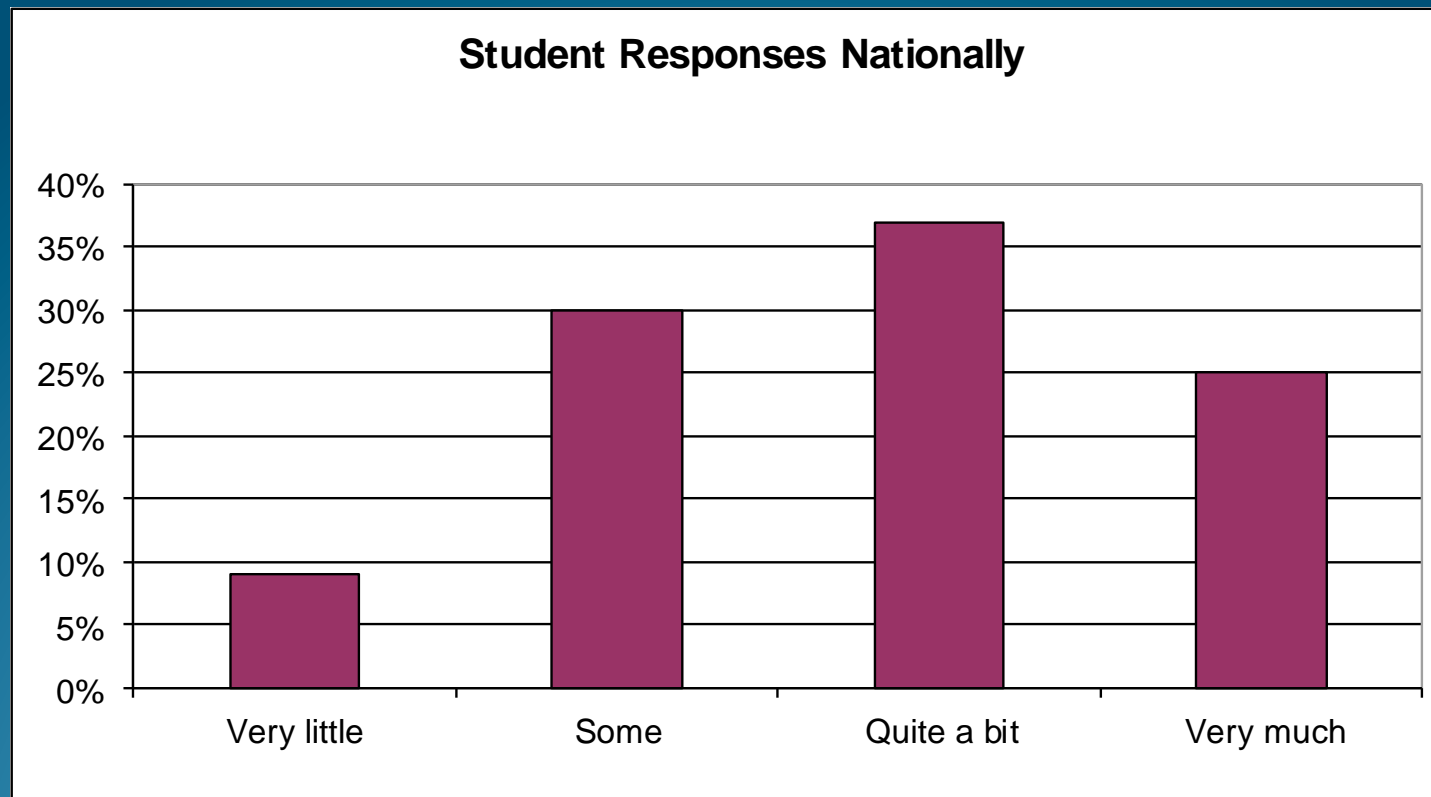
## \*NSSE Question

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

Video

\*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

How We Assess - Determines What Students Learn

# History of CAT Development

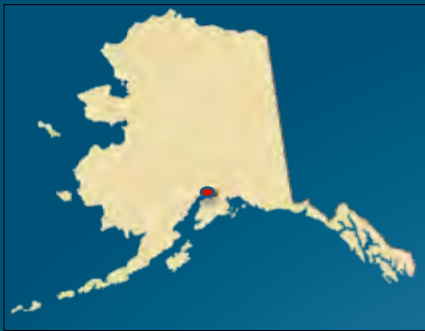
Preliminary Work  
At TTU 2000 - 2004



Refine Test with National Input  
Expand National Dissemination  
& Support Assessment in NSF  
Projects



# Over 200 Institutions Collaborating



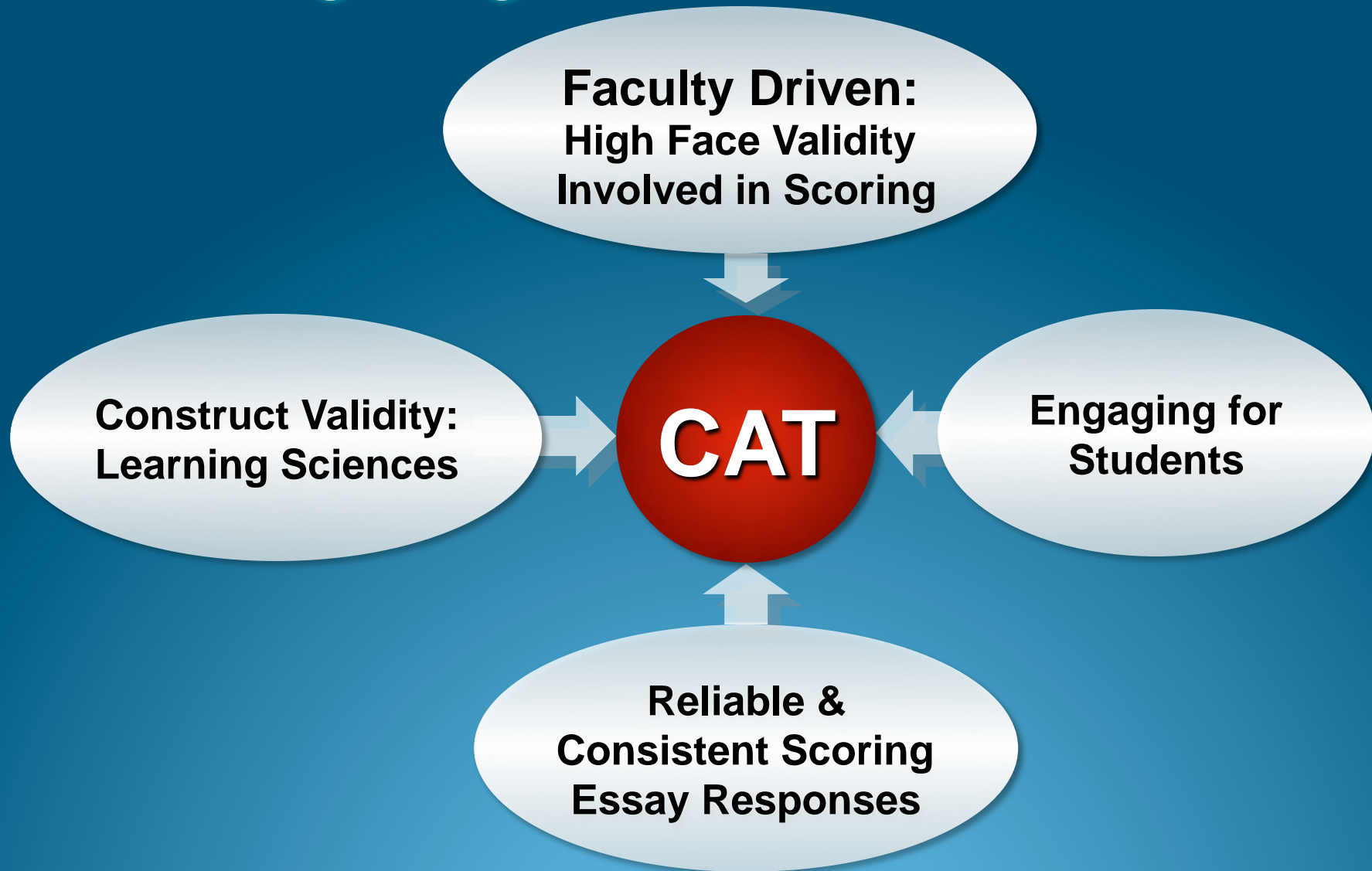
Guam



Hawaii



# Designing the CAT Instrument



# 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.

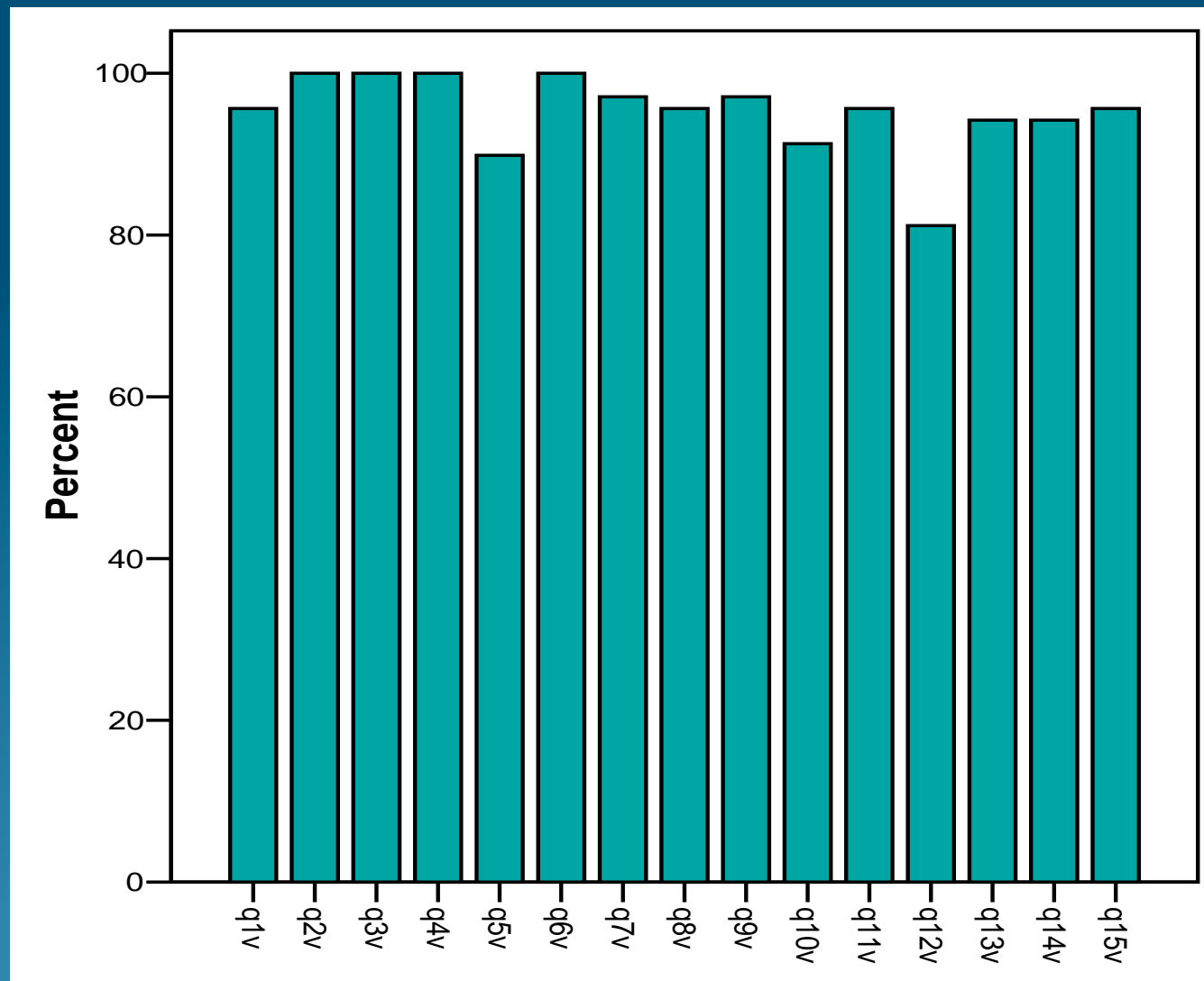
Learn & apply new information.

Use mathematical skills to solve real-world problems.

## Communication

Communicate ideas effectively.

# Faculty Evaluations of Question Validity



# CAT Statistics

|            | ACT    | SAT    | Academic Profile | Grade Point Average |
|------------|--------|--------|------------------|---------------------|
| <b>CAT</b> | 0.501* | 0.516* | 0.562*           | 0.295*              |

|            | CCTST<br>(California Critical Thinking Skills Tests) | CAAP<br>Critical Thinking Module |
|------------|------------------------------------------------------|----------------------------------|
| <b>CAT</b> | 0.645*                                               | 0.691*                           |

# CAT Results with 2005 NSSE

(National Survey of Student Engagement)  
Multiple R = .490  
(explains 24% of variability in CAT)

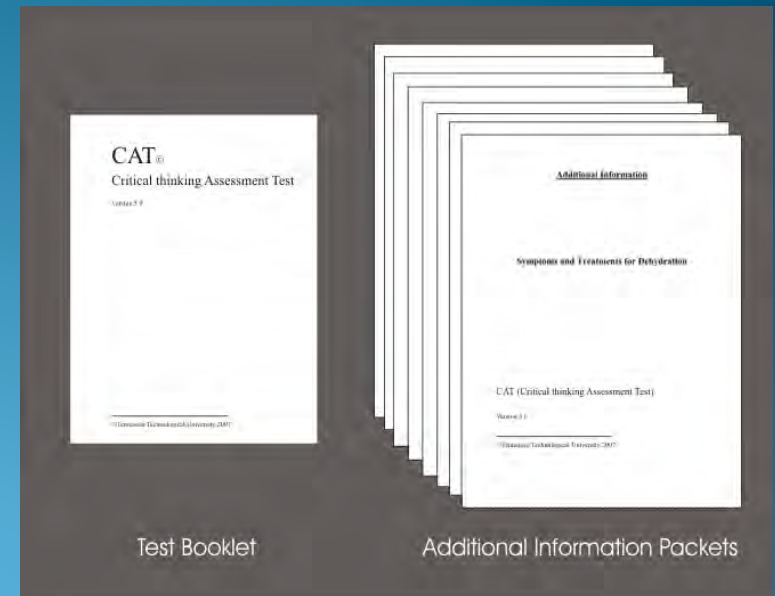
| NSSE Question                                                                                                                                               | Beta Coefficient |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| (2a) Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form. <i>(negative relationship)</i> | -.341 **         |
| (3b) Number of books read on your own (not assigned) for personal enjoyment or academic enrichment.                                                         | .277 **          |
| (11e) Thinking critically and analytically &<br>(11m) Solving complex real-world problems                                                                   | .244 **          |
| (7h) Culminating Senior Experience (thesis, capstone course, project, comprehensive exam, etc.)                                                             | .231 *           |

\* Significant at .01 level

\*\* Significant at .001 level

# CAT features

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



# Sample Disclosed Question

**A government scientist believes that an ingredient commonly used in bread causes criminal behavior. To support the hypothesis the scientist notes the following evidence.**

- **99.9 percent 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 described above strongly support the scientist's hypothesis? Yes \_\_\_ No \_\_\_**

**Are there other explanations for the data besides the scientist's hypothesis? If so, describe.**

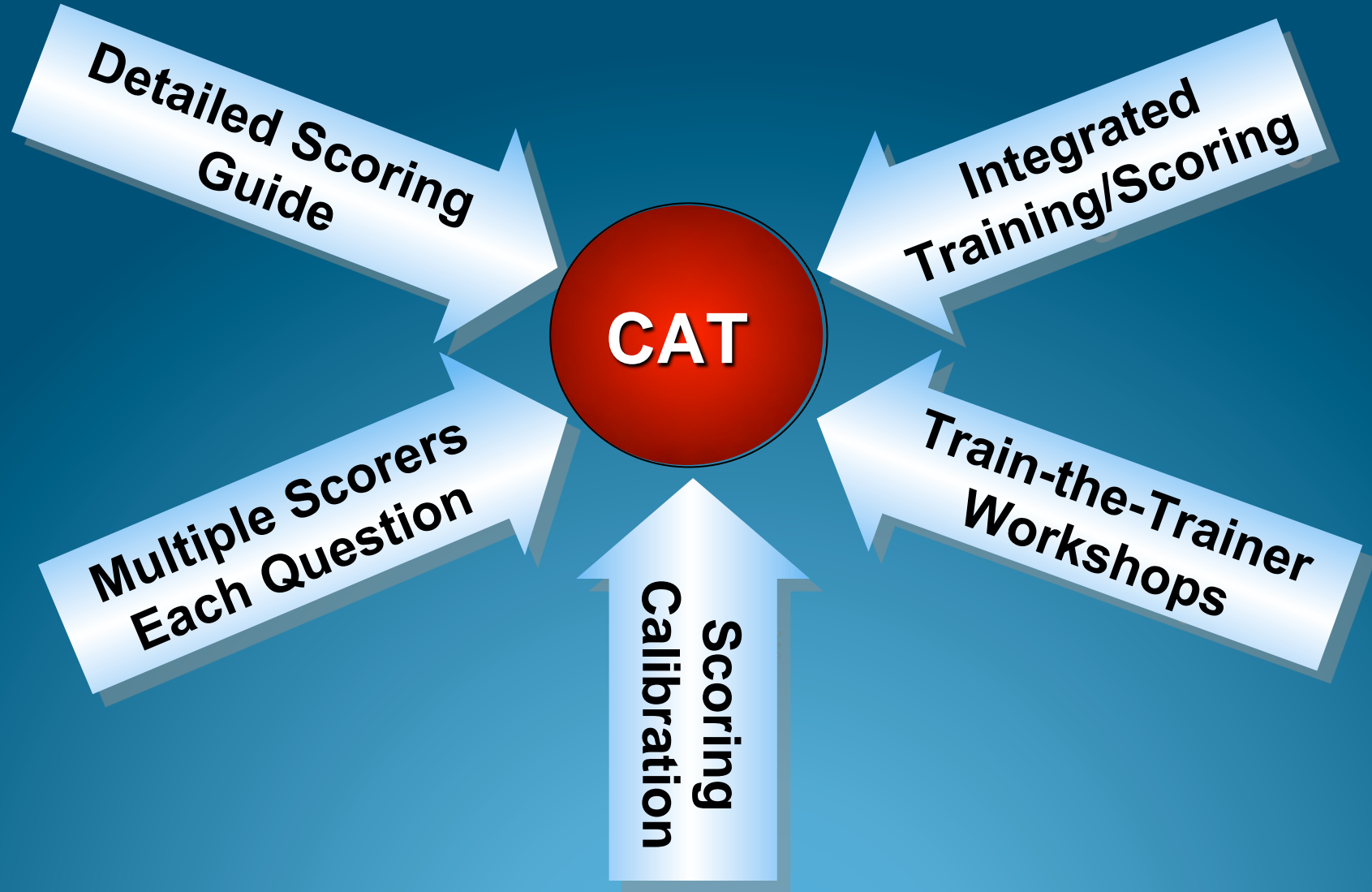
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**What kind of additional information or evidence would help evaluate the scientist's hypothesis?**

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# Ensuring Reliability of Scoring



# Mini-workshop vs. Standard Training

Mini-workshop

Standard Train-the-Trainer Workshop



Examine Sample  
Student Responses

Use Scoring Guide

Score Real Student Tests

Use Scoring Guide

Use Multiple Scorers

Deal with Ambiguous Responses

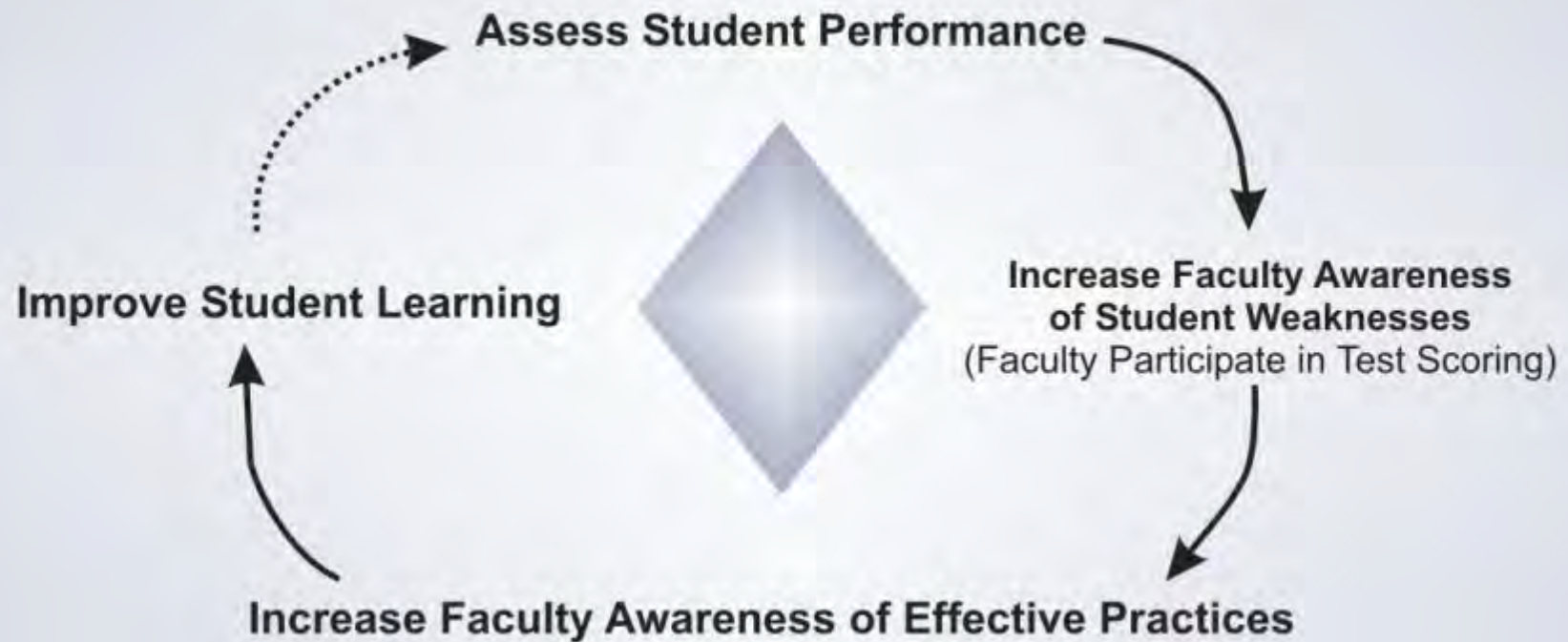
# CAT Test with Sample Student Responses

# Effective Practices Are A Moving Target

Video

# CAT as a Catalyst for Improvement

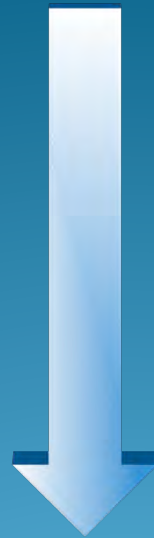
## Closing the Loop in Assessment and Quality Improvement



# Faculty Are Using the CAT To



**Identify Student  
Weaknesses**



**Improve  
Course Assessments**



**Identify Strategies for  
Improving  
Critical Thinking**

# Identify Relevant Skill Areas on Checklist

# Using the CAT as a Model for Developing Better Discipline Specific 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**



# Discipline Specific Analog

Read the following thesis from a student's analysis of Claude McKay's poem "If We Must Die":

"If We Must Die" is a poem about having valor on the battlefield. The speaker is a military commander rallying his troops before a big battle. This is evident by looking at the war-like language McKay uses throughout the poem, such as "let us nobly die," "we must meet the common foe," "our precious blood," and "dying, but fighting back."

1. To what extent do the quotations provided support the student's interpretation of the poem?
2. Provide an alternative interpretation of McKay's use of war-like language.
3. Identify 3 types of additional information that would help you investigate McKay's intent in writing the poem and explain why each source would be helpful.

# **Using Headlines to Develop Discipline Analog**

**Girls Who Play Soccer Have More Success in  
STEM Fields**

**Consuming High Fat Dairy Products Leads to  
Lower Obesity than Consuming Low Fat Dairy  
Products**

**Frequent Reliance on Social Services Yields  
Shorter Life Span**

**Eating Fast Food Leads to Depression**

# Skill Set 2: Encouraging Effective Course Assessments

**Separate relevant from irrelevant information when searching for information to solve a real-world problem.**

**Identify and explain the best solution for a real-world problem using relevant information.**

**Explain how changes to a real-world problem situation might alter the recommended solution.**



**Selecting New  
Lab Equipment**

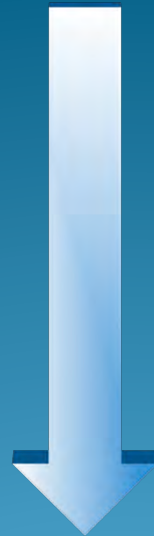
**Solving a Community  
Problem – Feral Cats**

**Designing a Set  
For a Play**

# Discipline Specific Assessments Modeled on the CAT



**Are Used in a Wide  
Variety of Courses**



**Are Used to Evaluate  
Real-World Problem Solving**



**Can be Integrated with  
Portfolios**

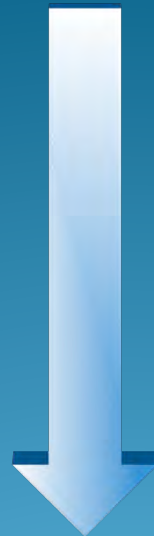
# The CAT has Been Used with Many High Impact Practices for Teaching Critical Thinking



# What Are We Learning From National Use of the CAT



**Faculty Involvement  
is Beneficial**



**Faculty Can Improve  
Course Assessments**



**Strategies for Improving  
Critical Thinking**



# CRITICAL THINKING ASSESSMENT TEST

TTU HOME CRITICAL THINKING ASSESSMENT TEST SUCCESSFUL PROJECTS

in depth

Home

CAT Info

Contacts

Reports

Grants

Using CAT

Training

Video Resources

Improving CAT Performance

Contact Us

## 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](mailto:LTEMESV@clemson.edu)) or Dr. Terri Bruce ( [terri@clemson.edu](mailto: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](mailto: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

# Various CT Assessments

## **CAT**

**Portfolios, Rubrics, & other Tests  
(CLA, CCTST, CAAP CT module)**

**Student Performance**

**IDEA Teaching Evaluations  
NSSE/CSSE & other surveys**

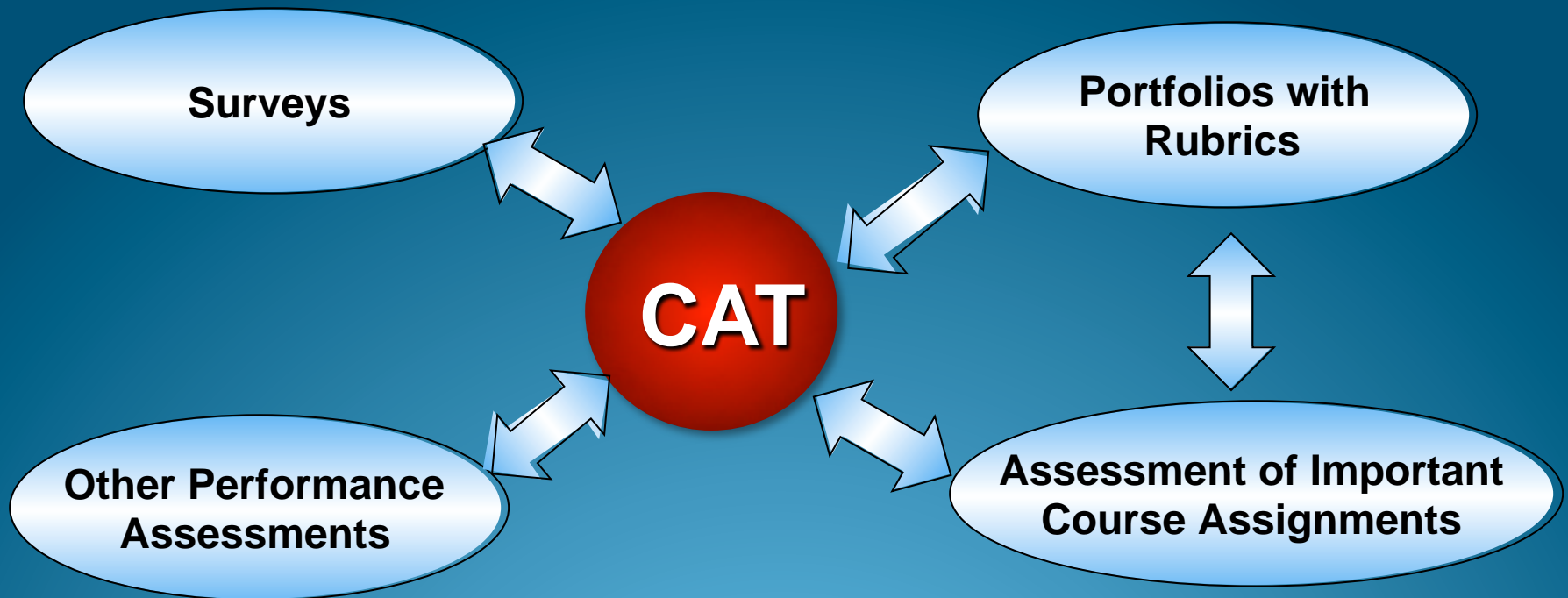
**Student Perceptions**

**Alumni & Employer surveys**

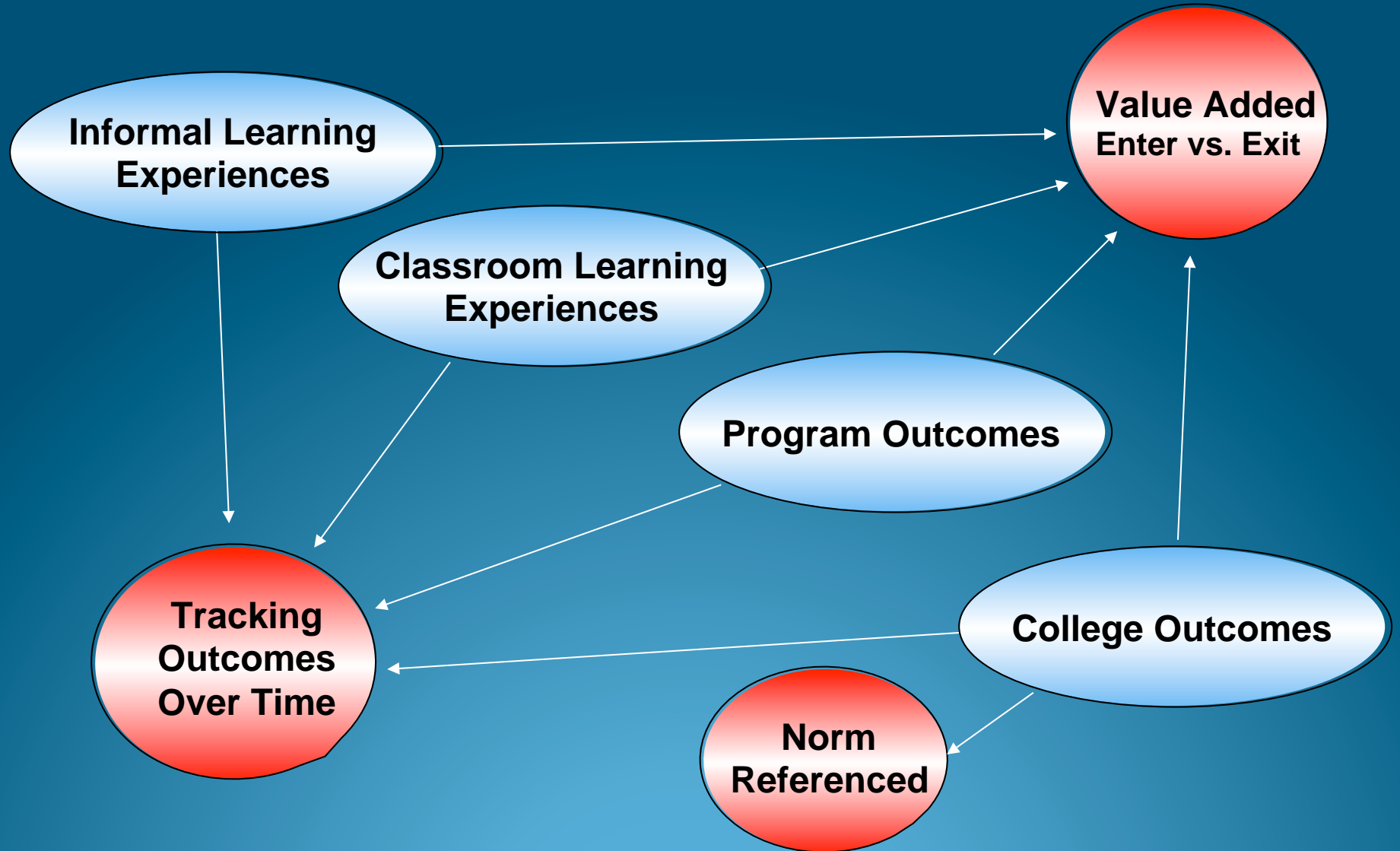
**Alumni/Employer  
Perceptions**



# Using Multiple Measures



# Assessment Uses of CAT



# CAT Institutional Reports

Sample Report  
*Page # 31 of Manual*

\_\_\_\_\_  
Name of Institution

### Student Information

Answer Selection: Correct = ● Incorrect = ✕ ⊗ ⊖

| Student ID Number |   |   |   |   |   |   |   |   |   | What is your Age? |   | Local Code |   |   |   |   |
|-------------------|---|---|---|---|---|---|---|---|---|-------------------|---|------------|---|---|---|---|
| 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0                 | 0 | 0          | 0 | 0 | 0 | 0 |
| 1                 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1                 | 1 | 1          | 1 | 1 | 1 | 1 |
| 2                 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2                 | 2 | 2          | 2 | 2 | 2 | 2 |
| 3                 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3                 | 3 | 3          | 3 | 3 | 3 | 3 |
| 4                 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4                 | 4 | 4          | 4 | 4 | 4 | 4 |
| 5                 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5                 | 5 | 5          | 5 | 5 | 5 | 5 |
| 6                 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6                 | 6 | 6          | 6 | 6 | 6 | 6 |
| 7                 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7                 | 7 | 7          | 7 | 7 | 7 | 7 |
| 8                 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8                 | 8 | 8          | 8 | 8 | 8 | 8 |
| 9                 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9                 | 9 | 9          | 9 | 9 | 9 | 9 |

1. What is your gender? *Select One.* (M) (F)

Note: Please answer BOTH Questions 2 and 3.

2. Are you Spanish/Hispanic/Latino? *Select One.* (Y) (N)

3. What is your race? *Select one or more categories to indicate your race (from U.S. Census Categories).*

- |                                                        |                                                                 |
|--------------------------------------------------------|-----------------------------------------------------------------|
| <input type="radio"/> White                            | <input type="radio"/> Asian                                     |
| <input type="radio"/> Black or African American        | <input type="radio"/> Native Hawaiian or Other Pacific Islander |
| <input type="radio"/> American Indian or Alaska Native | <input type="radio"/> Other race                                |

4. Do you consider English your primary language? *Select One.* (Y) (N)

5. Rate your proficiency with the English Language. *Select level of proficiency.*

- |           |           |      |      |      |
|-----------|-----------|------|------|------|
| Excellent | Very Good | Good | Fair | Poor |
| (E)       | (V)       | (G)  | (F)  | (P)  |

6. What is your class standing?

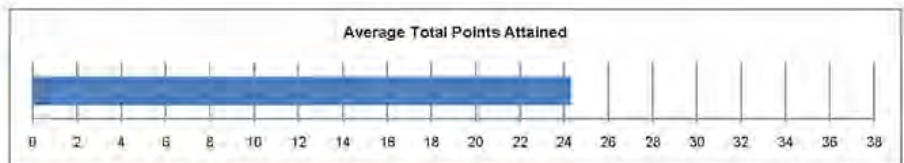
- |          |           |        |        |
|----------|-----------|--------|--------|
| (F)      | (S)       | (J)    | (S)    |
| Freshman | Sophomore | Junior | Senior |

7. Undergraduate or Graduate?

- |               |          |
|---------------|----------|
| (U)           | (G)      |
| Undergraduate | Graduate |

**CAT Overview: Descriptive Statistics for CAT Total Score**  
**Sample Institution: Date 2010**

|                 | N  | Min.  | Max.  | Mean  | Std. Dev |
|-----------------|----|-------|-------|-------|----------|
| CAT Total Score | 99 | 11.00 | 36.00 | 24.32 | 5.92     |



**CAT Demographics: Descriptive Statistics for Sample**

|                |               | Freq. | Freq. % |
|----------------|---------------|-------|---------|
| Gender         | Male          | 48    | 48.5%   |
|                | Female        | 51    | 51.5%   |
| Class Standing | Freshman      | 36    | 36.7%   |
|                | Sophomore     | 31    | 31.6%   |
|                | Junior        | 18    | 18.3%   |
|                | Senior        | 15    | 15.3%   |
| Class          | Undergraduate | -     | -       |
|                | Graduate      | -     | -       |
| Age            | ≤ 20 years    | 72    | 72.7%   |
|                | 21-25 years   | 26    | 26.3%   |
|                | ≥ 26 years    | 1     | 1.0%    |

|        |                                           | Freq. | Freq. % |
|--------|-------------------------------------------|-------|---------|
| Race** | White                                     | 61    | 61.6%   |
|        | Black or African American                 | 9     | 9.1%    |
|        | American Indian or Alaska Native          | 0     | 0.0%    |
|        | Asian                                     | 29    | 29.3%   |
|        | Native Hawaiian or Other Pacific Islander | 1     | 1.0%    |
|        | Other Race                                | 1     | 1.0%    |

\*\*The cumulative percent may exceed 100% as students are allowed to select more than one category.

|                                        |           | Freq. | Freq. % |
|----------------------------------------|-----------|-------|---------|
| Proficiency with the English Language* | Excellent | 71    | 73.2%   |
|                                        | Very Good | 17    | 17.5%   |
|                                        | Good      | 9     | 9.3%    |
|                                        | Fair      | 0     | 0.0%    |
|                                        | Poor      | 0     | 0.0%    |

\* Self-rated

|                                      |  | Freq. | Freq. % |
|--------------------------------------|--|-------|---------|
| Spanish/Hispanic/Latino Ethnicity    |  | 5     | 5.1%    |
| Considered English primary language? |  | 86    | 86.9%   |

**CAT Means Comparison Report**  
**Sample Institution: Date 2010 (N=25)**

| Evaluate and Interpret Info | Problem Solving | Creative Thinking | Effective Comm. | Skill Assessed by CAT Question                                                                  | Institution  |              |                                        |                          |
|-----------------------------|-----------------|-------------------|-----------------|-------------------------------------------------------------------------------------------------|--------------|--------------|----------------------------------------|--------------------------|
|                             |                 |                   |                 |                                                                                                 | Pre Mean     | Post Mean    | Probability of difference <sup>a</sup> | Effect Size <sup>b</sup> |
| X                           |                 |                   |                 | Q1 Summarize the pattern of results in a graph without making inappropriate inferences.         | .48          | .52          |                                        |                          |
| X                           |                 |                   | X               | Q2 Evaluate how strongly correlational-type data supports a hypothesis.                         | .39          | .45          |                                        |                          |
|                             |                 | X                 | X               | Q3 Provide alternative explanations for a pattern of results that has many possible causes.     | .79          | 1.37         | *                                      | + .58                    |
|                             | X               | X                 | X               | Q4 Identify additional information needed to evaluate a hypothesis.                             | .81          | 1.46         | **                                     | + .78                    |
| X                           |                 |                   |                 | Q5 Evaluate whether spurious information strongly supports a hypothesis.                        | .58          | .55          |                                        |                          |
|                             |                 | X                 | X               | Q6 Provide alternative explanations for spurious associations.                                  | .91          | 1.30         | *                                      | + .46                    |
|                             | X               | X                 | X               | Q7 Identify additional information needed to evaluate a hypothesis.                             | .58          | 1.00         | **                                     | + .68                    |
| X                           |                 |                   |                 | Q8 Determine whether an invited inference is supported by specific information.                 | .45          | .55          |                                        |                          |
|                             |                 | X                 | X               | Q9 Provide relevant alternative interpretations for a specific set of results.                  | .70          | 1.12         | *                                      | + .55                    |
| X                           | X               |                   |                 | Q10 Separate relevant from irrelevant information when solving a real-world problem.            | 3.39         | 3.15         |                                        |                          |
| X                           | X               |                   | X               | Q11 Use and apply relevant information to evaluate a problem.                                   | 1.15         | 1.21         |                                        |                          |
|                             | X               |                   |                 | Q12 Use basic mathematical skills to help solve a real-world problem.                           | .79          | .82          |                                        |                          |
| X                           | X               |                   |                 | Q13 Identify suitable solutions for a real-world problem using relevant information.            | .88          | .67          |                                        |                          |
| X                           | X               |                   | X               | Q14 Identify and explain the best solution for a real-world problem using relevant information. | 1.30         | 1.34         |                                        |                          |
|                             | X               | X                 | X               | Q15 Explain how changes in a real-world problem situation might affect the solution.            | .30          | .82          | **                                     | + .68                    |
| <b>CAT Total Score</b>      |                 |                   |                 |                                                                                                 | <b>13.51</b> | <b>16.33</b> | <b>***</b>                             | <b>+ .55</b>             |

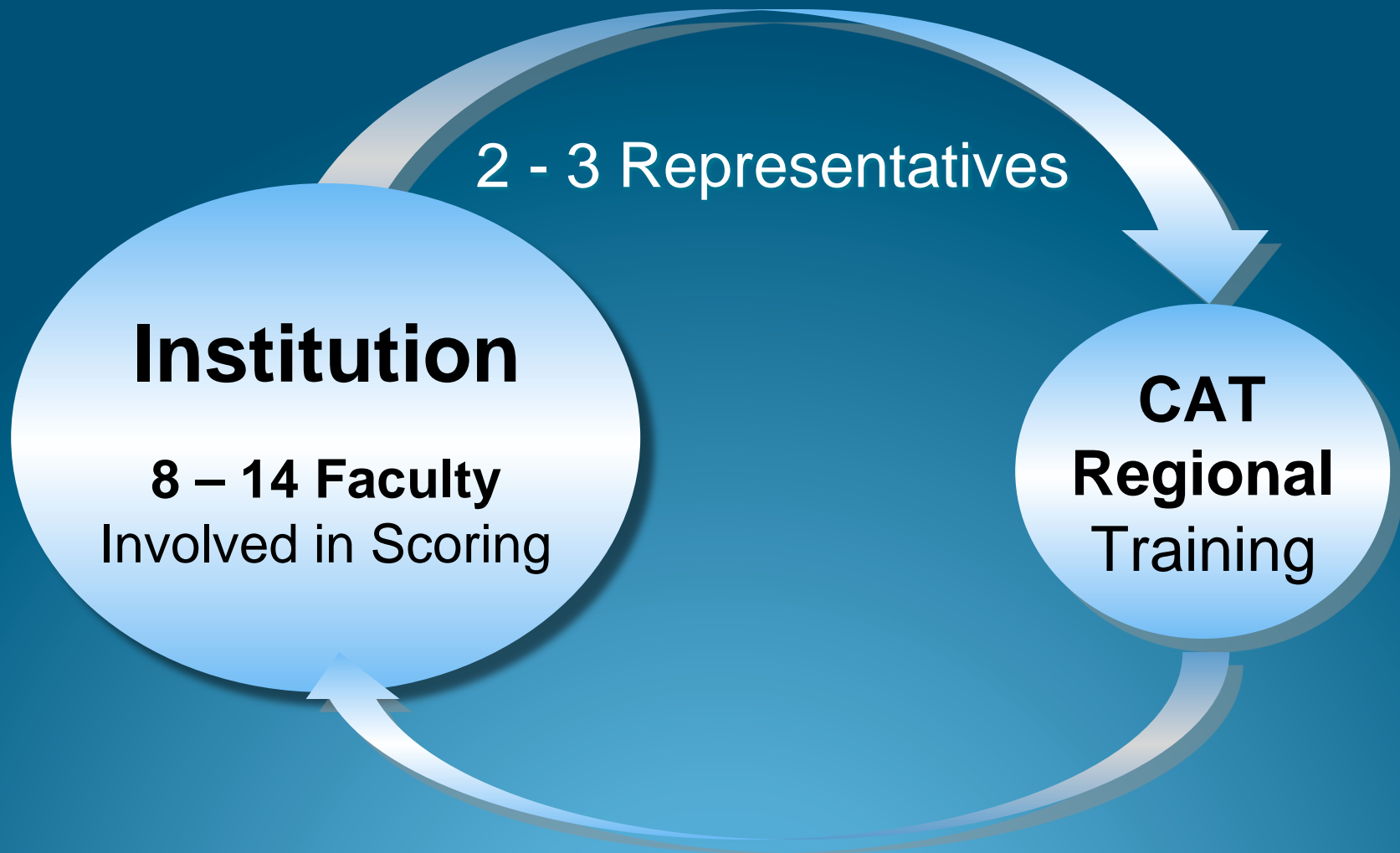
<sup>a</sup> \* p<.05 \*\*p<.01 \*\*\*p<.001 (2-tailed)

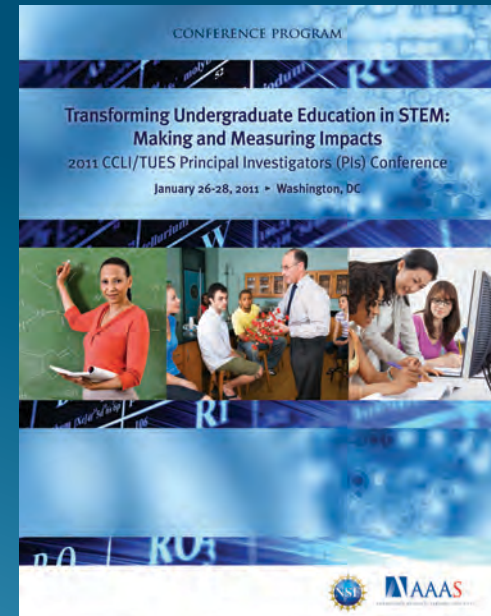
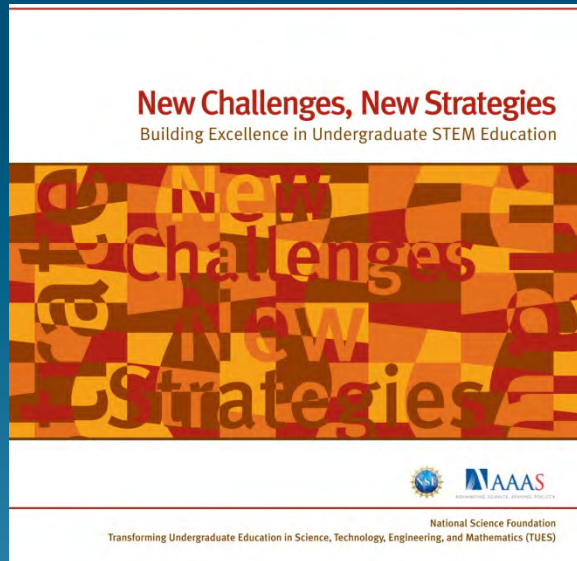
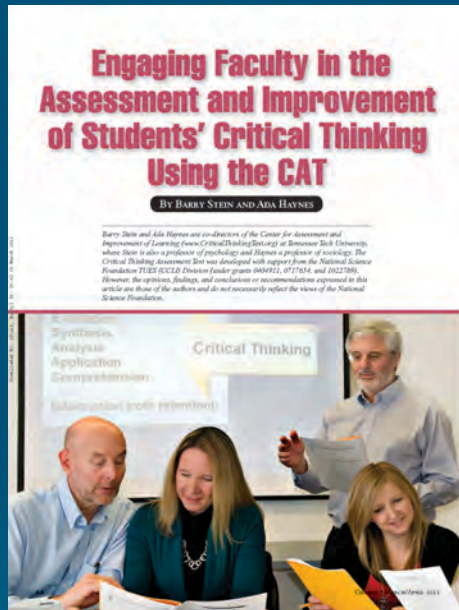
<sup>b</sup> Mean difference divided by pooled group standard deviation.  
 (0.1 - 0.3 = small effect; 0.3 - 0.5 = moderate effect; >0.5 = large effect)

The map of skills covered by each question above is a suggested theoretical guide for interpreting results.

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# National Dissemination Model





[www.CriticalThinkingTest.org](http://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.