

Preparing Students for Their Future By Improving Their Critical Thinking Skills

Ada Haynes

Co-Director Center for
Assessment and
Improvement of
Learning

Tennessee Tech
University

Paul Hert

Assessment and
Program Coordinator
Mt. San Jacinto College



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 - 2017

Over 280 Institutions Collaborating



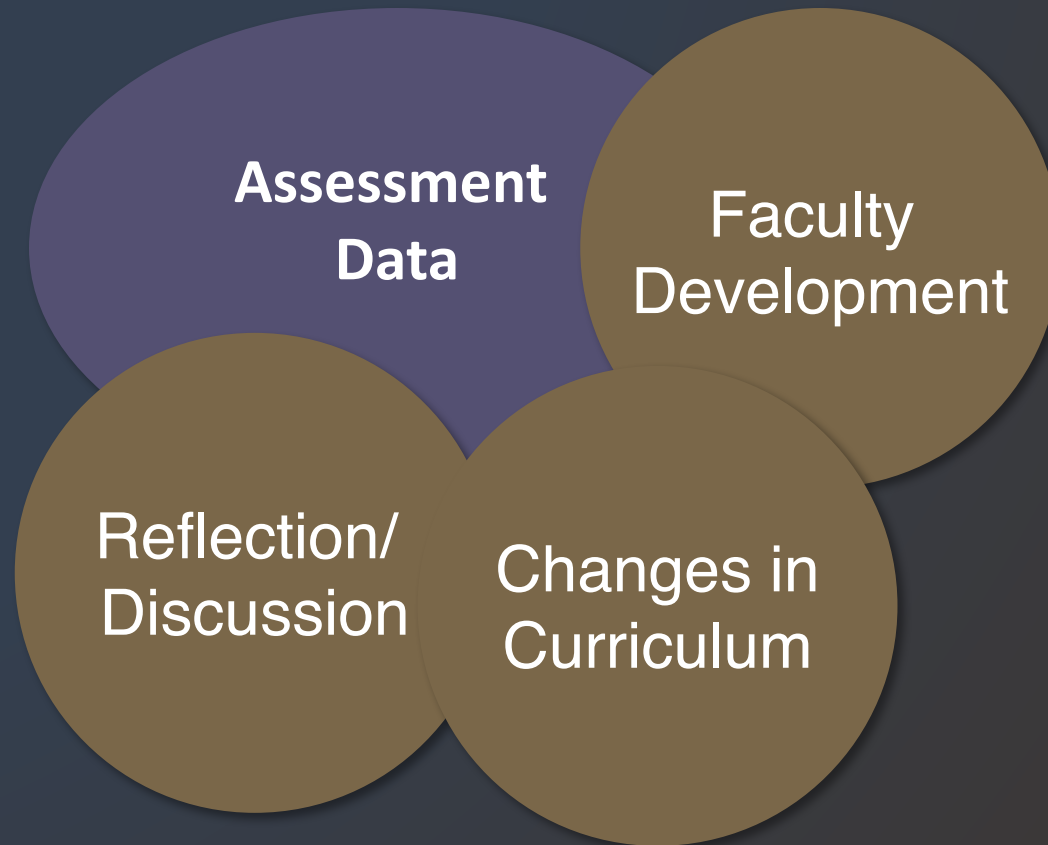
Guam



Hawaii



Selecting the CAT



CAT Features

One hour exam

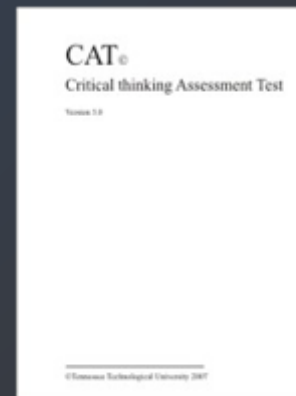
Mostly short answer essay

Faculty scored in workshops

Detailed scoring guide

Reliable

Valid



Test Booklet



Additional Information Packets

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.

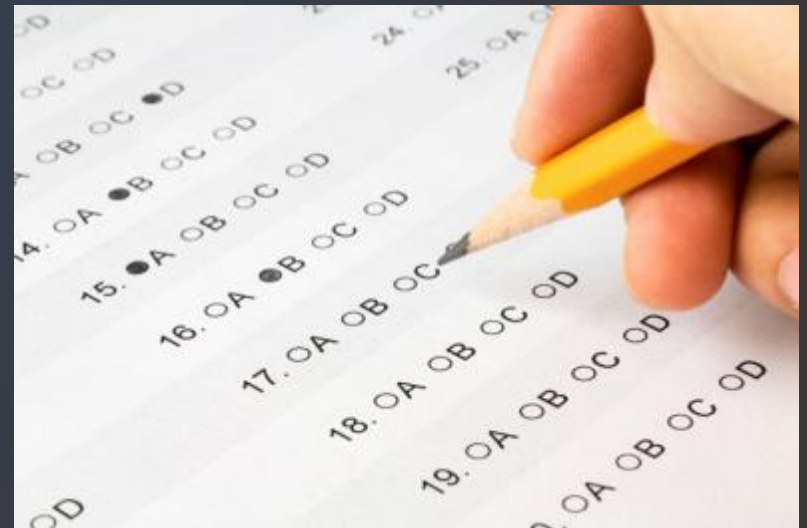
Learning & Problem Solving

- 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.

Understanding the Disconnect



Type of Classroom Assessments
Impact What Students Learn

Teaching Critical Thinking



Use the CAT to Assess
Critical Thinking

ASSESSING & IMPROVING

Use the CAT as a Model for
Better Course Assessments

CAT Classroom Applications

- Designed to complement high impact educational practices.
- Encourage students to develop critical thinking skills while learning discipline content.



Sample Disclosed Question

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

- 99.9% of the people who committed crimes consumed bread prior to committing crimes.
- Crimes 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 from the data besides the scientist's hypothesis? If so, describe.

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

Critical Thinking Skill Set 1

How strongly does information support an idea.

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

Creating a Community

Identify
Student
Weaknesses

Recognize Faculty
Strength
and Weaknesses

Develop a
Teaching
Community

Implement
Effective
Practices

Use
Appropriate
Assessments





Using the CAT Test at MSJC

Overview

- Pre-Test/Post Test Format: Beginning and End of 17-week Semester
- Fall 2012: English 103 (Critical Thinking) and Math 96 (Int. Algebra)
 - CAT Design: Matched Students
- 2016-17: English 101 (Fresh. Comp. – FYE), Math 96 (FYE), Biology 115 (Topics in Biology – Lecture and Lab for non-majors)
 - CAT Design: Unmatched students
 - Scoring for these three classes is not complete

Faculty Involvement

- Five faculty have administered the test to their sections.
- Three have attended CAT “Train the Trainers” Seminars...
- Two are creating CAT Classroom Applications
- Multiple faculty have participated in scoring the CAT tests.

•Take Away

- Just because you are scoring a critical thinking test doesn't mean you can't increase your critical thinking skills!

Significant Improvement – Math 96 F12

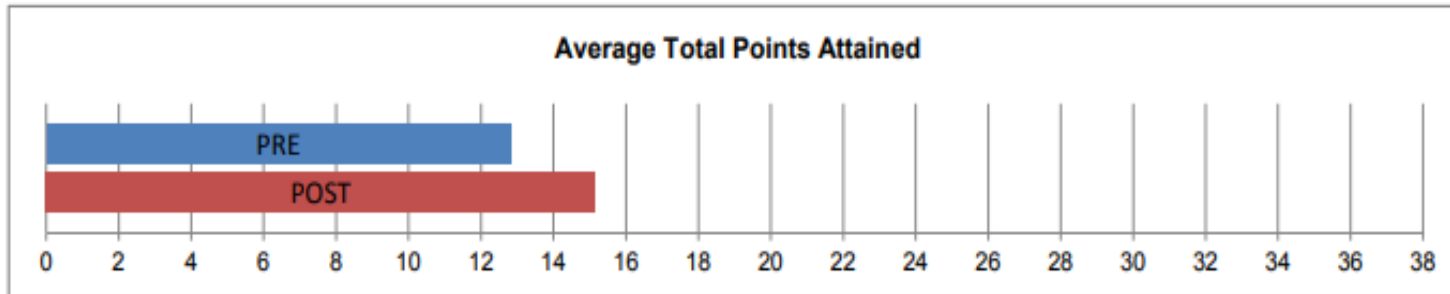
- Section utilized “Class Addenda” (CA) which reinforced real number properties introduced in prior course
- There were 7 CA; the first 5 studied the properties, each of the last two required students to supply the property used to justify each step in a linear equation solution. Examples of completed CA available to students as a reference.
- Students had 2 weeks to complete each CA; very little class time was spent on addendas 1 – 5 and 7.
- CA 6 and 7 were “capstones” for the project.
- Each CA was worth 5 points (lowest score dropped).
- Class Points: 30 points possible on the addenda plus 10 for taking CAT (40 out of 740)

General Section Statistics

- 27 CAT students (section began with 45, finished with 32)
- Grade Distribution:
 - A: 3
 - B: 7
 - C: 12
 - D: 2
 - F: 3
- 14 White, 10 Hispanic, 13 male, 14 female, 9 Freshman, 13 Sophomores, 23 students were 25 years old (or less)

CAT Statistics

		N	Min.	Max.	Mean	Std. Dev
CAT Total Score	PRE	27	6.00	22.00	12.83	3.96
	POST	27	4.00	23.00	15.16	4.75



CAT and Section Stats and Relationships

- Average Pre to Post Test Improvement: +2.33 (15.16 – 12.83)
- Correlations
 - CA Total score with CAT Post Test Score: $r = .366$, $p = .059$ (Pearson)
 - Grade with CAT Post Test Score: $r = .368$, $p = .061$ (Pearson)
 - “Scoring a 4 or 5 on either CA 6 or CA 7” and improvement on the CAT: There was a significant relationship: $r = .451$, $p = .018$.

Raw Data

- Pre-Test Score (Week 5)
- Post-Test Score (Week 15, approximately)
- Score Difference
- Success on CAs (a score of 4 or 5 on CA 6 or CA 7 (or both))
- Course Grade

Student	Pre-Test	Post-Test	Post/Pre Difference	CA 6,7 Success (4 or 5 on CA 6 or 7)	Course Grade
1	22.00	19.00	-3.00	N	C
2	10.00	17.00	7.00	Y	B
3	15.00	23.00	8.00	Y	C
4	16.00	18.00	2.00	Y	A
5	13.00	11.67	-1.33	N	C
6	14.00	13.00	-1.00	N	D
7	19.00	20.00	1.00	Y	B
8	12.00	9.00	-3.00	N	F
9	16.00	19.67	3.67	Y	C
10	12.00	18.00	6.00	N	F
11	9.00	12.00	3.00	Y	C
12	7.00	4.00	-3.00	N	F
13	13.00	19.00	6.00	Y	B
14	14.00	16.00	2.00	N	A

Student	Pre-Test	Post-Test	Post/Pre Difference	CA 6,7 Success (4 or 5 on CA 6 or 7)	Course Grade
15	17.00	19.00	2.00	Y	C
16	10.00	20.00	10.00	Y	C
17	8.00	14.00	6.00	N	C
18	6.00	7.00	1.00	N	B
19	10.00	11.00	1.00	N	C
20	11.00	16.00	5.00	N	D
21	11.00	11.00	0.00	N	C
22	9.00	11.00	2.00	Y	C
23	21.00	23.00	2.00	Y	B
24	15.00	15.00	0.00	N	B
25	12.33	18.00	5.67	Y	A
26	11.00	13.00	2.00	Y	C
27	13.00	12.00	-1.00	Y	B

Pre- to Post-Test Increase

- 19 of the 27 students increased their CAT score (from the Pre-Test to the Post-Test).
- The (overall) average increase was 3.97 points.
- Of the 19 whose CAT score increased, 13 “succeeded” on the CAs. Their average increase was 4.18 points (0.21 points above the overall average).
- For the 6 who didn’t “succeed” on the CAs, their average increase was 3.5 points (0.47 points below the overall average).

Student	Pre-Test	Post-Test	Post/Pre Difference	CA 6,7 Success (4 or 5 on CA 6 or 7)	Course Grade
16	10.00	20.00	10.00	Y	C
3	15.00	23.00	8.00	Y	C
2	10.00	17.00	7.00	Y	B
13	13.00	19.00	6.00	Y	B
17	8.00	14.00	6.00	N	C
10	12.00	18.00	6.00	N	F
25	12.33	18.00	5.67	Y	A
20	11.00	16.00	5.00	N	D
9	16.00	19.67	3.67	Y	C
11	9.00	12.00	3.00	Y	C
4	16.00	18.00	2.00	Y	A
14	14.00	16.00	2.00	N	A
23	21.00	23.00	2.00	Y	B
15	17.00	19.00	2.00	Y	C

Student	Pre-Test	Post-Test	Post/Pre Difference	CA 6,7 Success (4 or 5 on CA 6 or 7)	Course Grade
26	11.00	13.00	2.00	Y	C
22	9.00	11.00	2.00	Y	C
7	19.00	20.00	1.00	Y	B
18	6.00	7.00	1.00	N	B
19	10.00	11.00	1.00	N	C
21	11.00	11.00	0.00	N	C
24	15.00	15.00	0.00	N	B
27	13.00	12.00	-1.00	Y	B
6	14.00	13.00	-1.00	N	D
5	13.00	11.67	-1.33	N	C
1	22.00	19.00	-3.00	N	C
8	12.00	9.00	-3.00	N	F
12	7.00	4.00	-3.00	N	F

Pre-Post Test Profile

Mt. San Jacinto College : March 2016 - Local Code: 2102

Evaluate and Interpret Info	Problem Solving	Creative Thinking	Effective Comm.		Skill Assessed by CAT Question	Institution/Department			
						Pre Mean	Post Mean	Probability of difference ^a	Effect Size ^b
X				Q1	Summarize the pattern of results in a graph without making inappropriate inferences.	0.78	0.83		
X			X	Q2	Evaluate how strongly correlational-type data supports a hypothesis.	0.52	0.85	*	+.44
		X	X	Q3	Provide alternative explanations for a pattern of results that has many possible causes.	0.75	0.99		
	X	X	X	Q4	Identify additional information needed to evaluate a hypothesis.	0.78	0.59		
X				Q5	Evaluate whether spurious information strongly supports a hypothesis.	0.52	0.56		
		X	X	Q6	Provide alternative explanations for spurious associations.	0.96	1.17		
	X	X	X	Q7	Identify additional information needed to evaluate a hypothesis.	0.59	0.63		
X				Q8	Determine whether an invited inference is supported by specific information.	0.56	0.63		
		X	X	Q9	Provide relevant alternative interpretations for a specific set of results.	0.37	0.74	*	+ .61
X	X			Q10	Separate relevant from irrelevant information when solving a real-world problem.	3.07	2.81		
X	X		X	Q11	Use and apply relevant information to evaluate a problem.	0.74	1.11	*	+ .57
	X			Q12	Use basic mathematical skills to help solve a real-world problem.	0.67	0.67		
X	X			Q13	Identify suitable solutions for a real-world problem using relevant information.	0.54	0.89		
X	X		X	Q14	Identify and explain the best solution for a real-world problem using relevant information.	1.33	2.07		
	X	X	X	Q15	Explain how changes in a real-world problem situation might affect the solution.	0.78	0.76		
CAT Total Score						12.83	15.16	**	+ .53

^a. * p<.05 **p<.01 ***p<.001 (2 -tailed)

^b. Mean difference divided by pooled group standard deviation.

(0.1 - 0.3 = small effect; 0.3 - 0.5 = moderate effect; >0.5 = large effect)

What's Next, Takeaways....

- (Much) more data is needed!!
- In terms of increasing critical thinking (and learning outcomes in general), support of “soft skills” matters.

Thank You

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.