

# Assessment in STEM Ethics Education

**Michael C. Loui**  
*Purdue University, and  
University of Illinois at  
Urbana-Champaign*

Working Ethics into the Conversation:  
Introducing STEM Faculty to Teaching Ethics  
National Academies of Science, Engineering,  
and Medicine

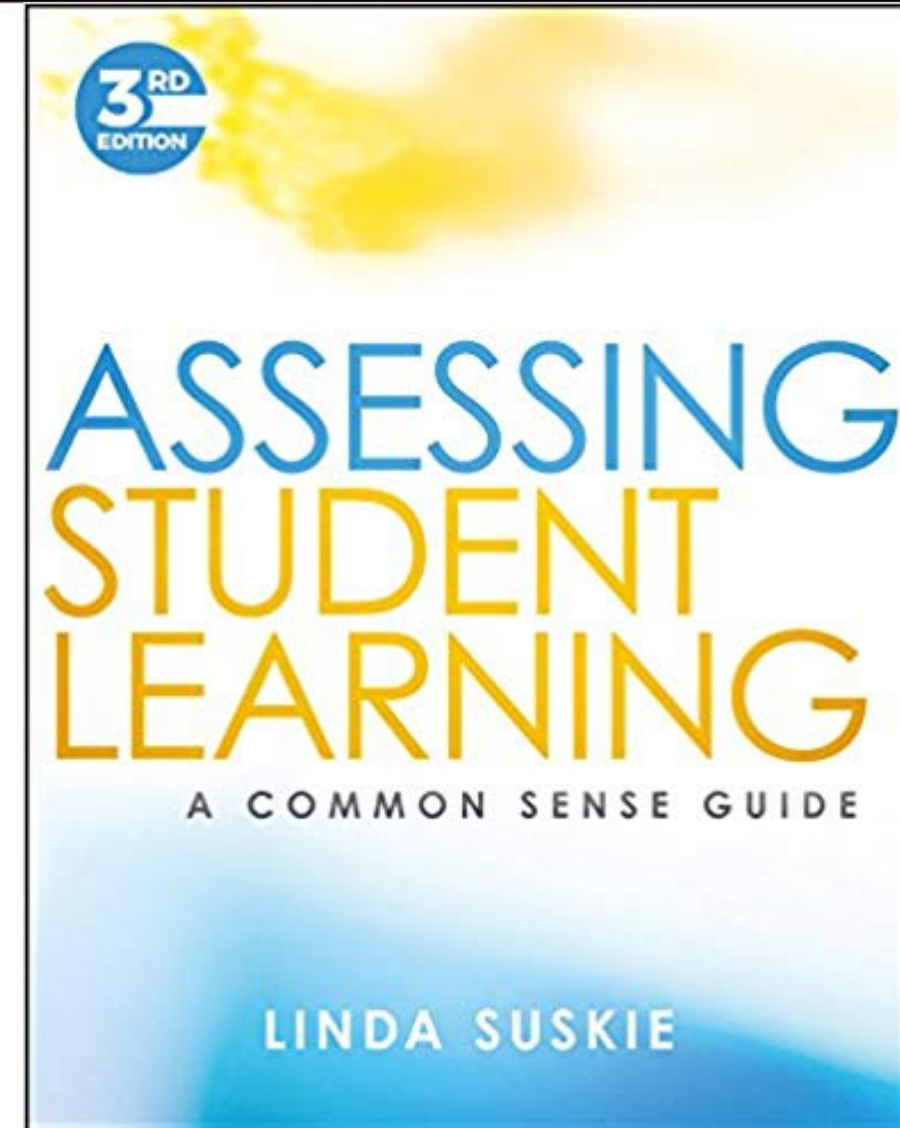
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“Educational assessment is the art of quantifying the unmeasurable.”

*Michael Loui (2019)*

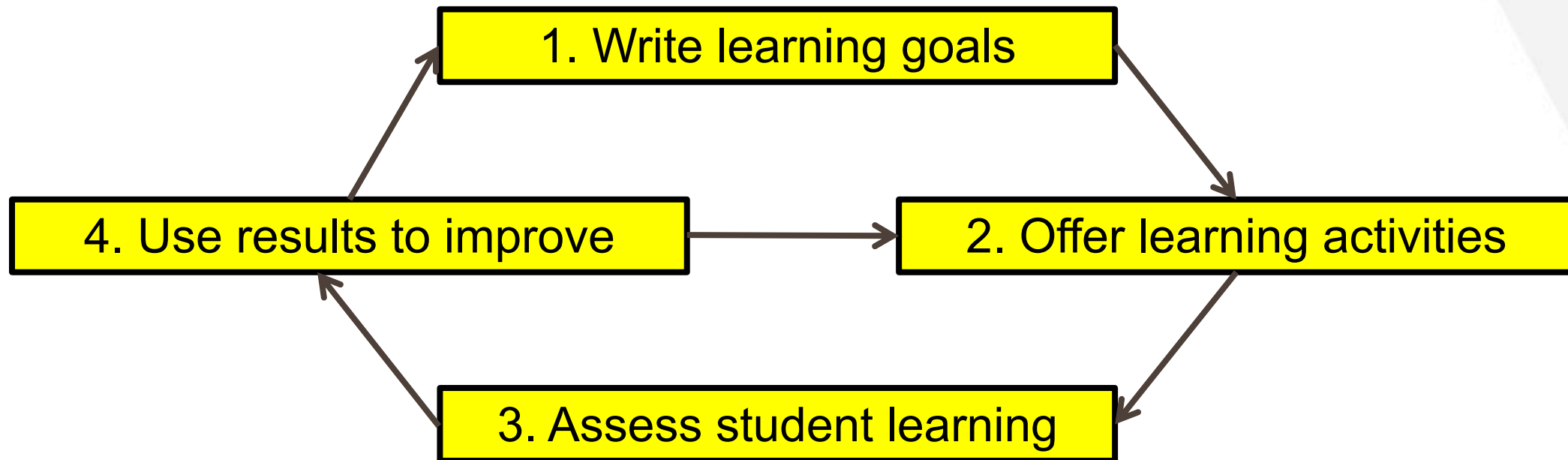
# What is assessment?

Assessment is the systematic collection and analysis of evidence of student learning





# Assessment is an integral part of the teaching and learning cycle



# Assessment is NOT the same as grading

A hand-drawn red oval containing the text "B+" in a red, cursive-like font. The oval is slightly tilted and has a thick, hand-painted appearance.



# What can you assess?

Students

Class sessions

Courses

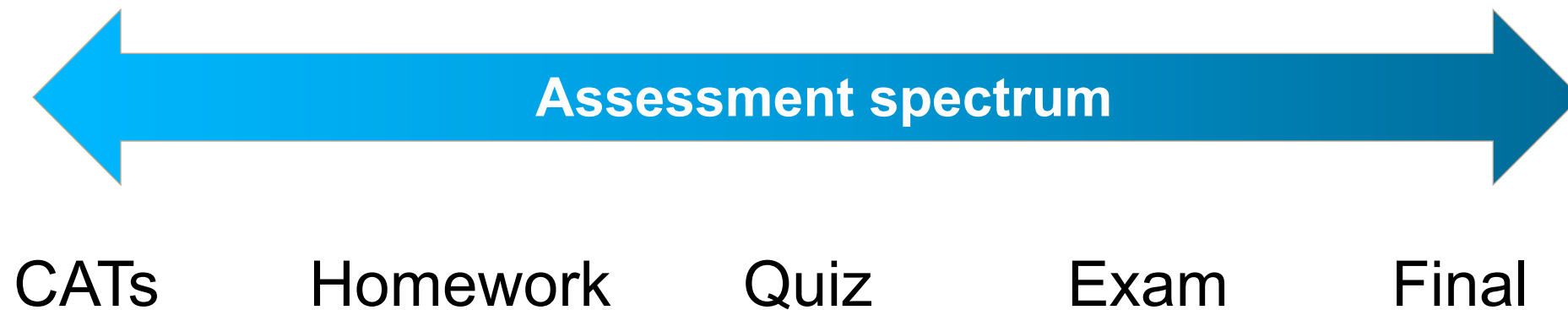
Programs



# What the purpose of your assessment?

Formative  
Improvement

Summative  
Accountability





# Classroom assessment techniques (CATs) are ...

Short, formative assessments of class sessions

Generally anonymous

## Minute Paper

1. What was the most important thing you learned during this class [today]?
2. What important question remains unanswered?



# More examples of CATs

**Muddiest Point** variation of Minute Paper:

What was the muddiest [most confusing] point in  
\_\_\_\_ [the text, the class, ...]?

**One-Sentence Summary:**

In a long sentence of about 50 words, define the  
term *engineering professional responsibility*.  
Address *who*, *what*, and *why*.

# CAT: Background Knowledge Probe

## Kansas City Hyatt walkway collapse

1. Have never heard of this
2. Have heard of it, but don't really know what it means
3. Have some idea what this means, but not too sure
4. Have a clear idea of what this means and can explain it

## Conflict of interest

1. Have never heard of this concept
2. Have heard of it, but don't really know what it is
3. Have some idea what it is, but not too sure
4. Have a clear idea of what it is and can explain

# CAT: Defining Features Matrix

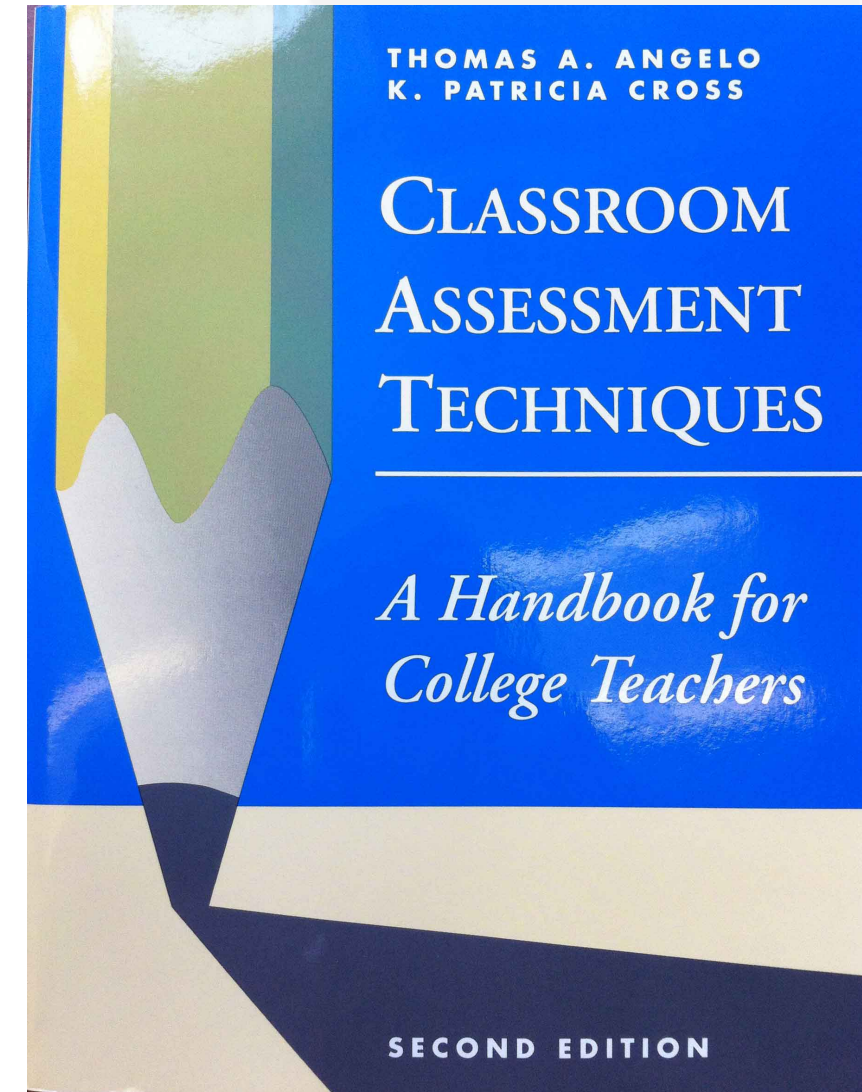
Features	Gift	Tip	Bribe	Grease payment
1. When given				
2. Size				
3. Purpose				
4. Legal considerations				



## Angelo & Cross (1993) said ...

CATs can be embedded in the regular work of an academic classroom

CATs provide “high information return for a very low investment of time and energy”  
(p. 154)



# **What CATs could you use when you teach ethics? How?**

Use worksheet

Think-Pair-Share with writing

1a. Silently think and write (3 min)

1b. Pair, share, and write further ideas (5 min)

“Cold calling”: randomly chosen reporters

(As a CAT, this activity is called “Application Cards”)



# What kinds of evidence can you collect?

## Direct evidence of student learning

- Student papers, performances, tests

- Portfolios

## Indirect evidence of student learning

- Self reports

- Satisfaction surveys

## Published assessment instruments



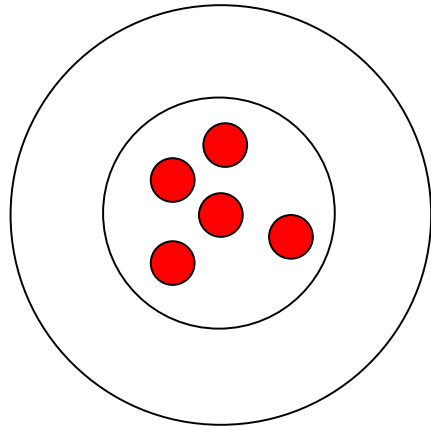


# How good is your evidence?

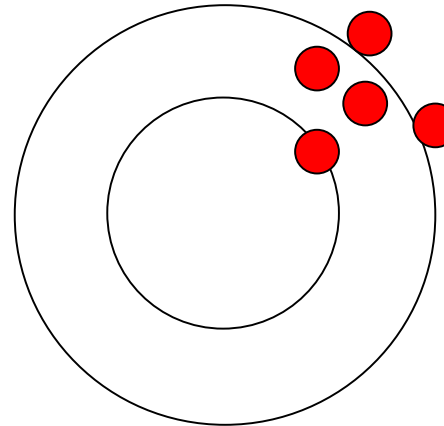
Validity refers to accuracy: are you measuring what you intend to measure?

Reliability refers to consistency: is your measurement repeatable?

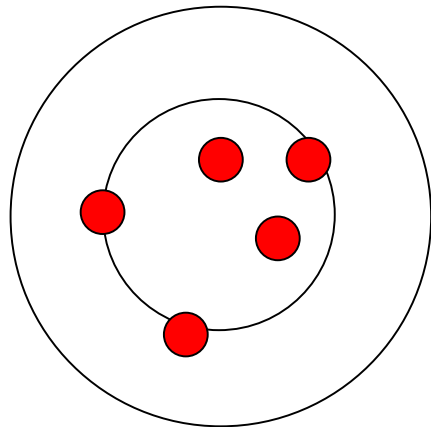
Assessments should be valid and reliable, but no assessment is perfect



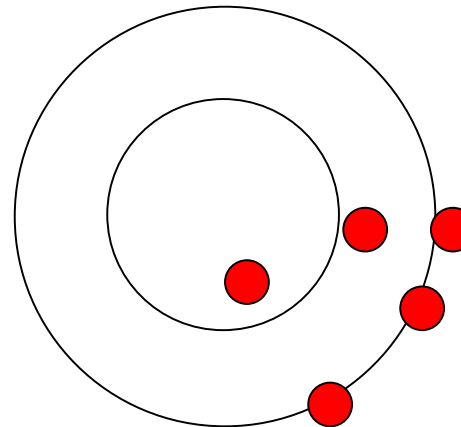
High V, High R



Low V, High R



High V, Low R



Low V, Low R

# **Assessment evidence should be aligned with learning goals**

Learning goals specify intended outcomes, what students should be able to do after instruction

Goals should be realistic, concrete, observable actions

Not “understand” or “appreciate”



# **After this course or module, ...**

Students will be able to recall that . . .

- IEEE has a code of ethics

- Engineers are responsible for safety

Students will be able to . . .

- Explain why engineering is a profession

- Distinguish between plagiarism and duplicate publication

- Identify a conflict of interest situation

# **After this course or module, . . .**

Students will be able to . . .

- Analyze the relative importance of conflicting values (e.g., individual privacy vs. community security)

- Design solutions to data sharing problems

- Justify decisions about authorship and allocation of credit

- Evaluate actions by referring to a code of ethics

Consider noncognitive outcomes: attitudes, dispositions , . . .

# **In general, learning goals should . . .**

Be concrete, observable, and measurable:

What students should be able to demonstrate

Not be vague

“Appreciate the importance of integrity”

“Behave honestly in the future”

Not focus on your own goals

“Cover the required material”



# **What learning goals do you want your students to achieve?**

Use worksheet

“By the end of this course/module/session, students should be able to . . .”

Think-Pair-Share with writing

2a. Silently think and write (3 min)

2b. Pair, share, and write further ideas (5 min)

Randomly chosen reporters

# Analyze student work with a rubric

Describe 3 to 5 performance levels for each learning goal

Summary sheet has example rubric (Keefer et al., 2014):

## Identify ethical issues / professional responsibilities

Expert (4)	More proficient (3)
Identify all relevant ethical issues in the case and how they relate to professional responsibilities. Identify and track concerns of primary & secondary stakeholders.	Identify more than one ethical issue and/or a professional responsibility. Identify and track concerns of the primary stakeholders.

## **Example: Summative assessment of ethics sessions in an undergraduate research program**

Loui & Revelo (2015) used a counter-balanced design

Pre-test: Half of students analyzed case A, other half analyzed case B

Post-test: Each student analyzed the other case

We scored all analyses scored blindly with a rubric

We found no significant pre-post differences



# Should you use a published instrument?

Published instruments generally ...

- Include evidence of quality (validity, reliability)

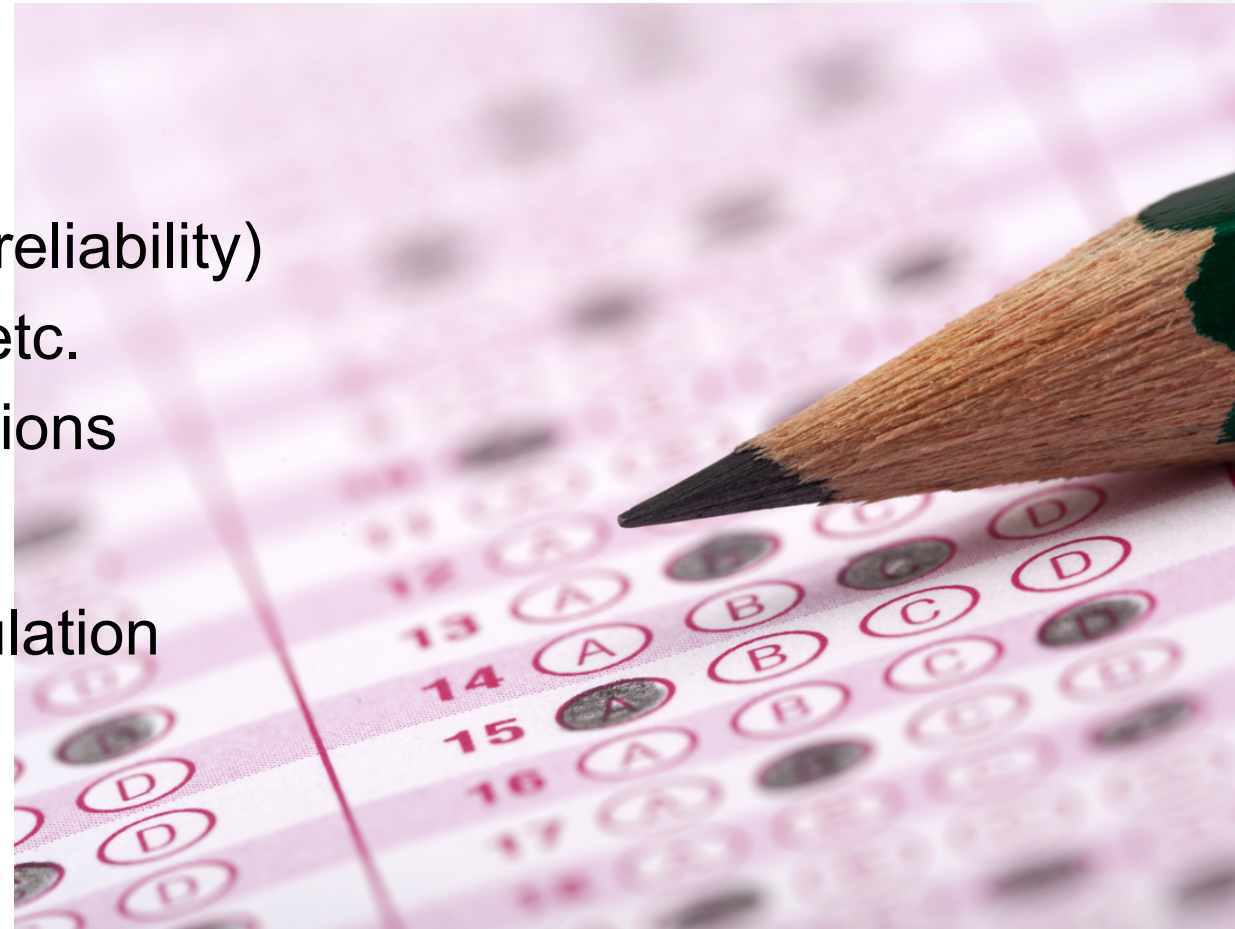
- Can measure motivation, attitudes, etc.

- Permit comparisons between institutions

Locally grown instruments ...

- Fit your learning goals, student population

- Can be less costly



# Some published instruments

Baseline test of responsible conduct of research (Heitman et al., 2007)

TESSE: Test of Ethical Sensitivity in Science and Engineering (Borenstein et al., 2008)

ESIT: Engineering and Science Issues Test (Borenstein et al., 2010)

EERI: Engineering Ethics Reasoning Instrument (Zhu et al., 2014)

EDM: Ethical Decision Making Measure (Mumford et al., 2006)

# Example: Ethical Decision Making Measure

Mumford et al. (2006) developed a situational judgment test for ethical decision making (EDM)

Each version has 28 items

Each item presents a scenario and eight possible actions

Students choose the two best options

Available at <http://ethics.publishpath.com/>



# Sample item from the Physical Science / Engineering version of the EDM

Jamie Palmeri conducts research on radar design at an applied research institute. As an expert in this area, she has been hired by an engineering company to develop a request for proposal (RFP) for an extensive redesign project. Palmeri is also coordinating and participating in the proposal review process. Nine proposals have passed a first screen by meeting the criteria outlined in the RFP. Palmeri and several others are currently conducting more extensive, blind reviews of the nine proposals. During the review, Palmeri recognizes through the content of the proposal that her advisor from graduate school has submitted one. The proposal is one of the top three and Palmeri sees high potential for collaborative research should this team of researchers win. What should Palmeri do? Choose two from the following:

- a. Withdraw from the review and selection process ...
- h. Evaluate her advisor's proposal conservatively

# Summary

Assessment is the systematic collection and analysis of evidence of student learning

Assessments can be formative or summative

Assessments should be aligned with learning goals

Assessments should be valid and reliable

We have seen examples of classroom assessments (CATs), a case analysis rubric, and a situational judgment test item

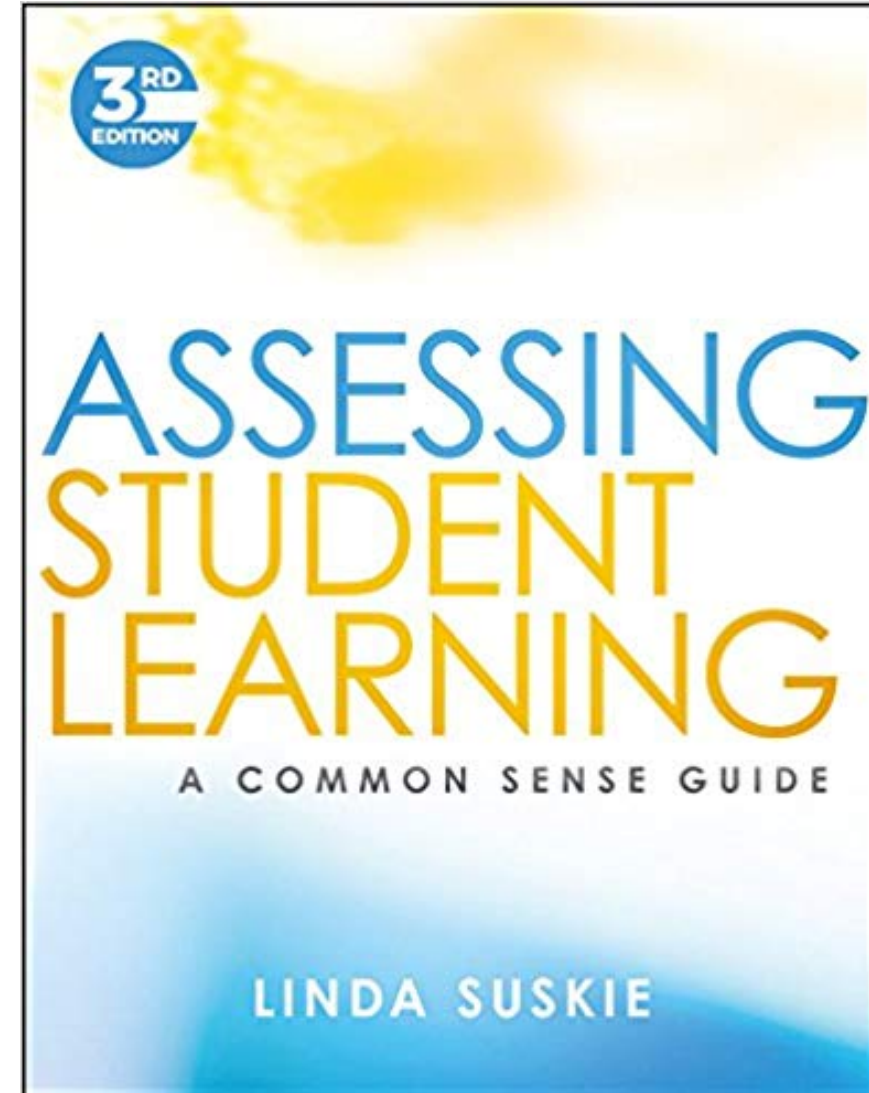
## Please complete a minute paper

What were the most important ideas that you learned in this presentation?

What questions do you still have?

Questions?

[mloui@purdue.edu](mailto:mloui@purdue.edu)





## References

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## Images

[http://2.bp.blogspot.com/-cQsEH6Anx3k/UW9jnr5F-VI/AAAAAAAAFAk/u1W7055\\_dT0/s320/b-plus-school-letter-grade.jpg](http://2.bp.blogspot.com/-cQsEH6Anx3k/UW9jnr5F-VI/AAAAAAAAFAk/u1W7055_dT0/s320/b-plus-school-letter-grade.jpg)

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