



**“How do you know your students are learning?”**

As you enter, list on the board:

- the forms of student assessment you currently use.

Optional

- your goals for this session ...

**How do you know your students are learning?**

**Why does student engagement matter?**

Adriana Signorini

Center for Research on Teaching Excellence

Students Assessing Teaching and Learning

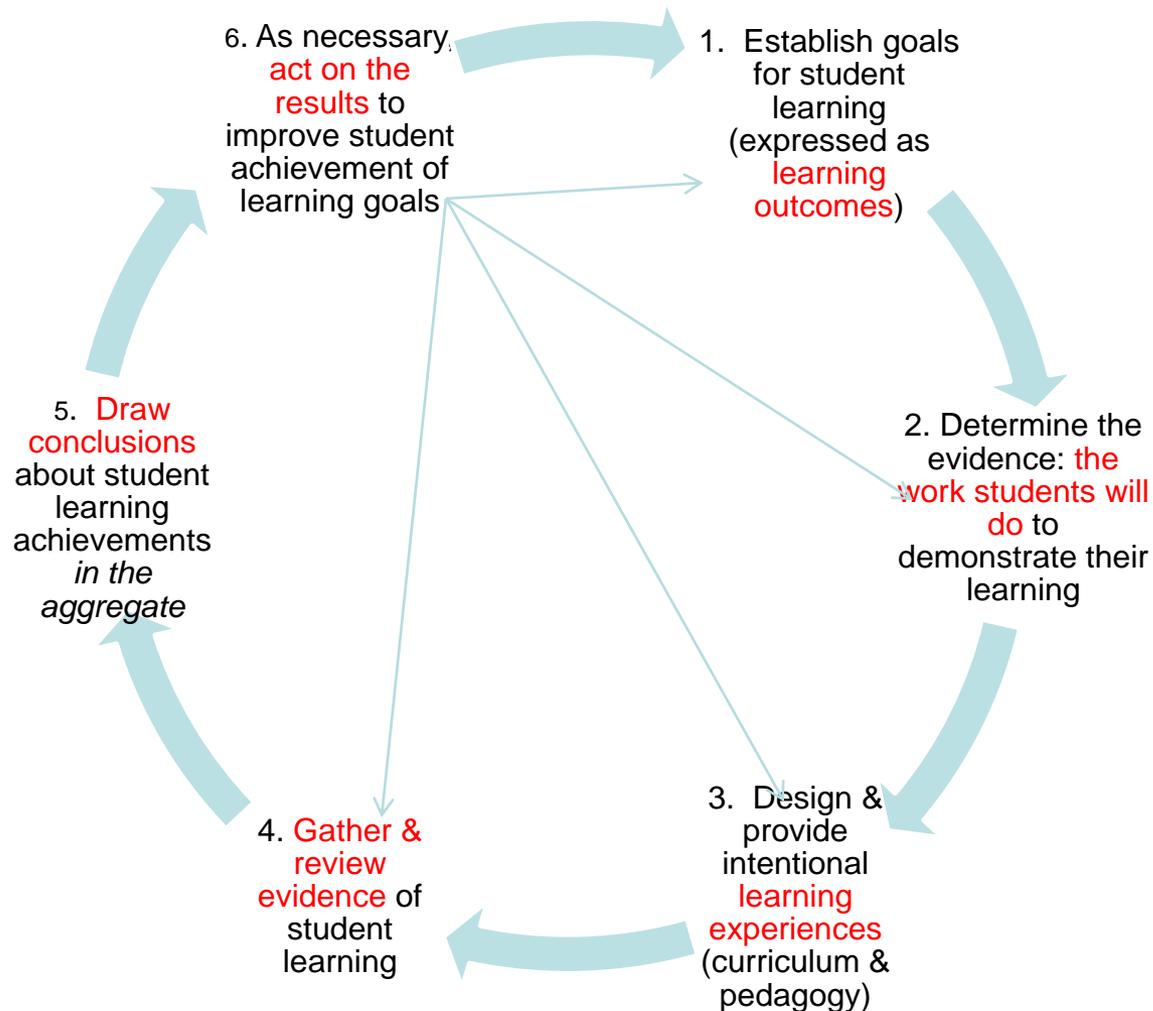


# Learning Outcomes

By the end of this session, you'll be able to ...

- Describe some elements of the learning cycle presented.
- List some classroom assessment tools which you are not using but could improve learning in your courses
- Identify the benefits of interactive-engagement and dare to give these activities a try.

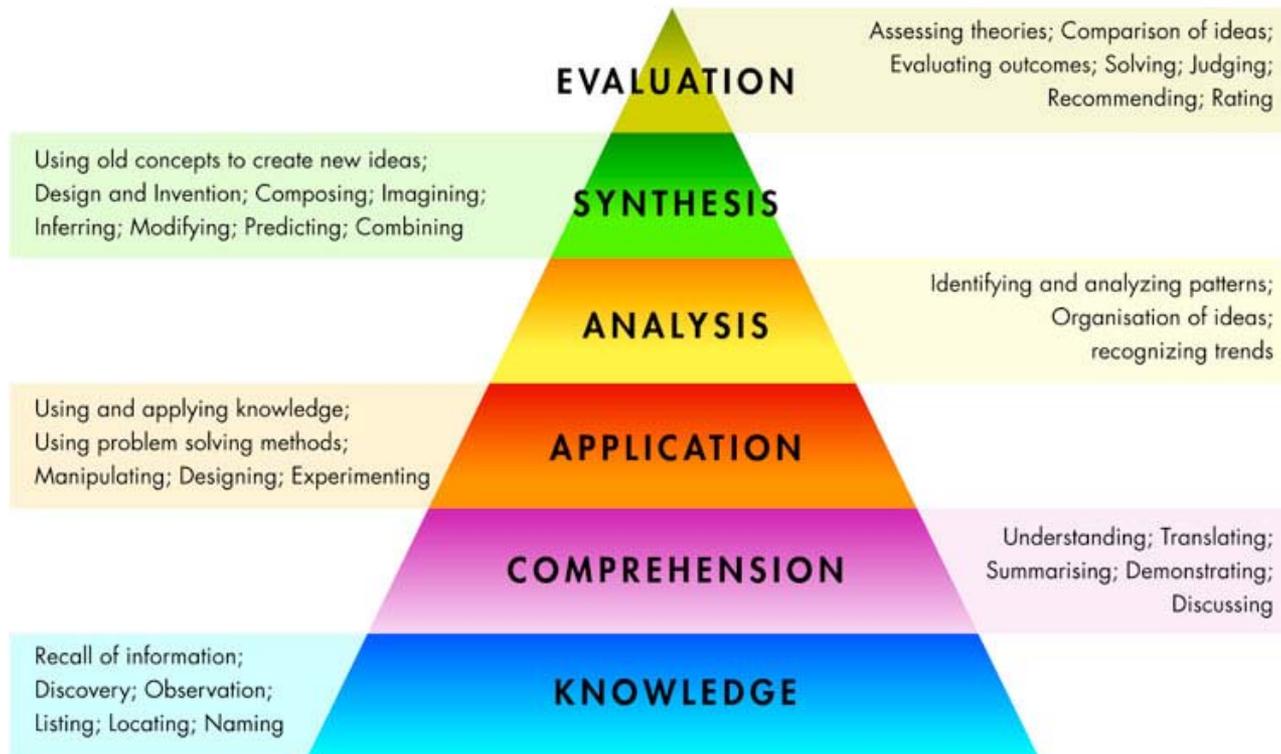
# What is assessment (of student learning)?



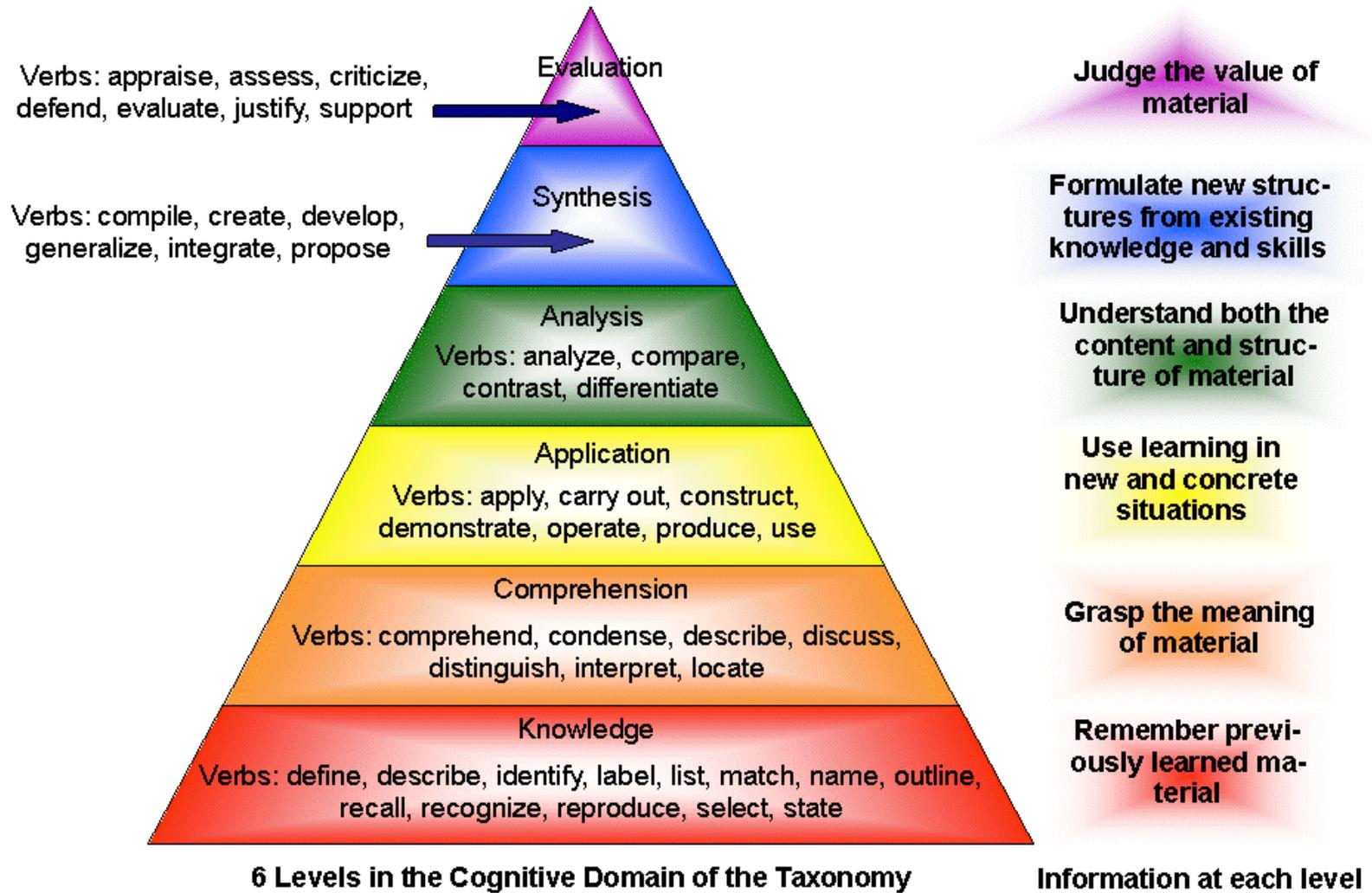
# What are the class learning outcomes?

Statements that focus on the outcomes we expect of students to do when they complete the course/ or class lesson

## B L O O M S TAXONOMY



# Bloom's Taxonomy



## Verbs useful for stating learning outcomes

Action Words for Bloom's Taxonomy					
Knowledge	Understand	Apply	Analyze	Evaluate	Create
define	explain	solve	analyze	reframe	design
identify	describe	apply	compare	criticize	compose
describe	interpret	illustrate	classify	evaluate	create
label	paraphrase	modify	contrast	order	plan
list	summarize	use	distinguish	appraise	combine
name	classify	calculate	infer	judge	formulate
state	compare	change	separate	support	invent
match	differentiate	choose	explain	compare	hypothesize
recognize	discuss	demonstrate	select	decide	substitute
select	distinguish	discover	categorize	discriminate	write
examine	extend	experiment	connect	recommend	compile
locate	predict	relate	differentiate	summarize	construct
memorize	associate	show	discriminate	assess	develop
quote	contrast	sketch	divide	choose	generalize
recall	convert	complete	order	convince	integrate
reproduce	demonstrate	construct	point out	defend	modify
tabulate	estimate	dramatize	prioritize	estimate	organize
tell	express	interpret	subdivide	find errors	prepare
copy	identify	manipulate	survey	grade	produce
discover	indicate	paint	advertise	measure	rearrange
duplicate	infer	prepare	appraise	predict	rewrite
enumerate	relate	produce	break down	rank	role-play
listen	restate	report	calculate	score	adapt
observe	select	teach	conclude	select	anticipate
omit	translate	act	correlate	test	arrange
read	ask	administer	criticize	argue	assemble
recite	cite	articulate	deduce	conclude	choose
record	discover	chart	devise	consider	collaborate
repeat	generalize	collect	diagnose	critique	collect

<http://www.teachthought.com/wp-content/uploads/2013/08/verbs-for-blooms-taxonomy-fi.jpg>



# Activity: Analyze a Learning Outcome (L.O.)

Choose one of the following two L.O.s:

- 1) Analyze it in relation the criteria for useful L.O.s.
- 2) Propose revisions as you feel appropriate.
- 3) Share your analysis with the rest.

L.O. 1: At the conclusion of this course, students will understand basic statistical analysis.

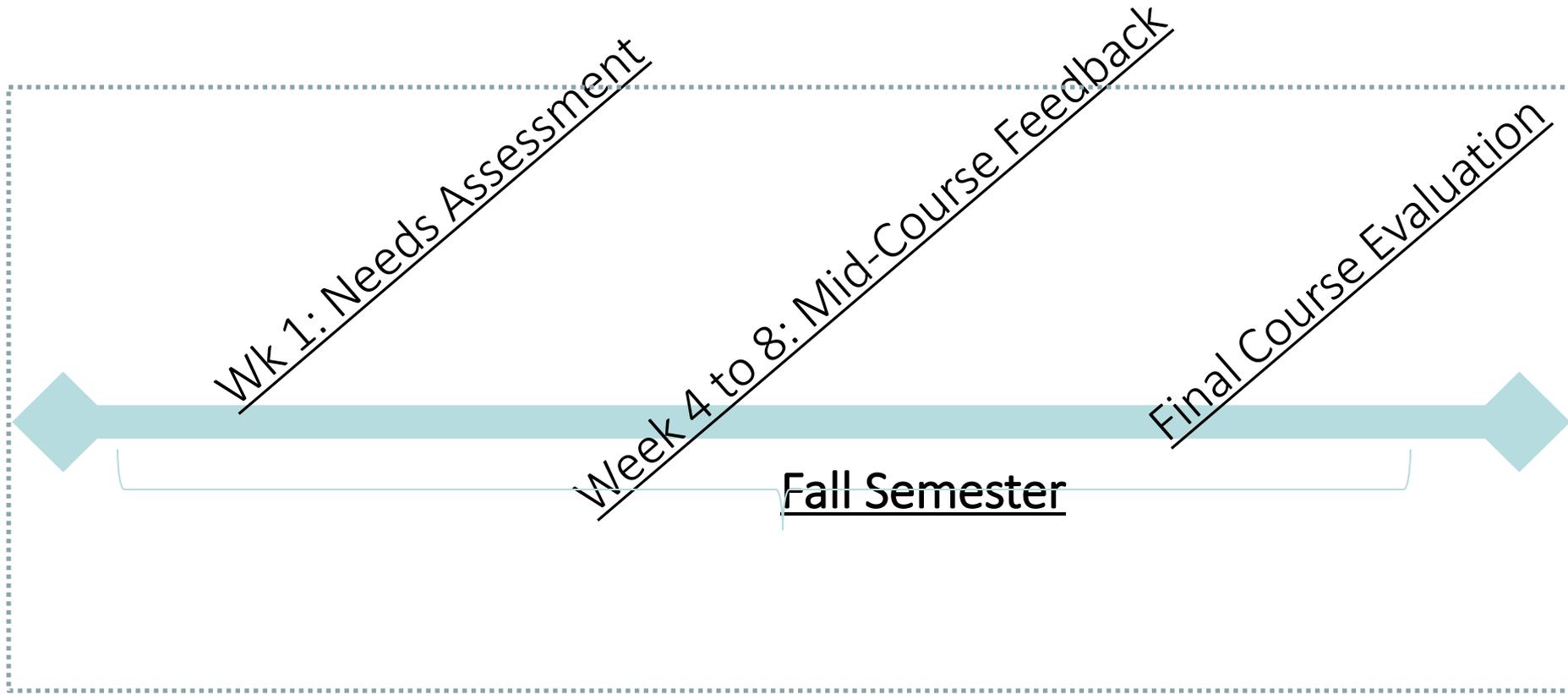
L.O. 2: At the conclusion of this course, students will be familiar with academic writing and speaking practices.

# Checklist for creating learning outcomes:

- Does the learning outcome identify what students will be able to do after the topic is covered?
- Is it clear how you would test achievement of the learning outcome?
- Do chosen verbs have a clear meaning?
- Is the verb aligned with the level of cognitive understanding expected of students? Could you expect a higher level of understanding?
- Is the terminology familiar/common? If not, is knowing the terminology a goal?
- Is it possible to write the outcome so it is relevant and useful to students (e.g. connected to their everyday life, or does it represent a useful application of the ideas)?



# Key Class Assessment Activities



Wk 1: Needs Assessment

Week 4 to 8: Mid-Course Feedback

Final Course Evaluation

Fall Semester

# Needs Assessment

- Pre/ Post Test
- Entry Survey



Prior Knowledge  
Attitudes  
Values



Your class  
expectations:  
OH, studying time,  
specific  
requirements, etc.



Campus Resources:  
Library/ Tutoring/  
Mentoring/ STEM Center,  
etc.



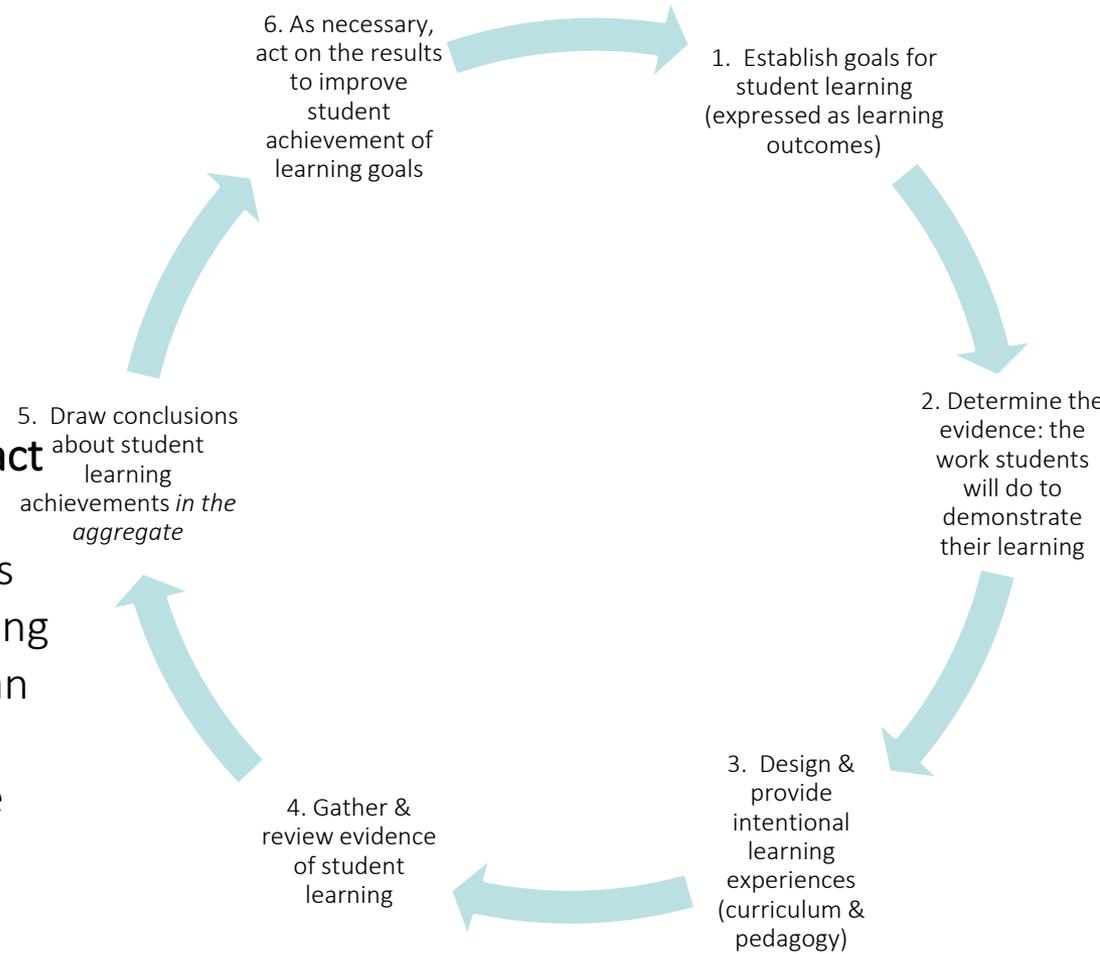
# Mid-Course Feedback



- It will benefit the same students who provide the feedback (Bullock, 2003).
- It provides opportunities for students to comment on specific behaviors or pedagogical strategies that are not covered by the standard end-of-semester evaluation questions.
- It provides the potential to improve end-of-semester evaluations and increase student exam performance (Overall and Marsh, 1979).
- Students respond positively when their comments result in changes to the course, leading to improved student attitudes about the class and/or instructor (Keutzer, 1993).

# Assessment Process: An Example

1. **Outcome:** Write a technical report
2. **Evidence:** Technical reports
3. **Design:**
  - Write reports weekly guided by rubric.
  - Detailed feedback provided consistent with rubric.
  - Track students' use of feedback.
- 4.-6. **Gather evidence, draw conclusions, act on results:**
  - Mid-semester: examines students improvements, finds students using feedback are improving more than others.
  - Shares this with class to motivate use of feedback to improve.
  - Continues to provide detailed feedback through multiple avenues.



# Assessment as *planning* cycle

1. Setting goals
2. Developing strategies
3. Outlining tasks
4. Evaluating success



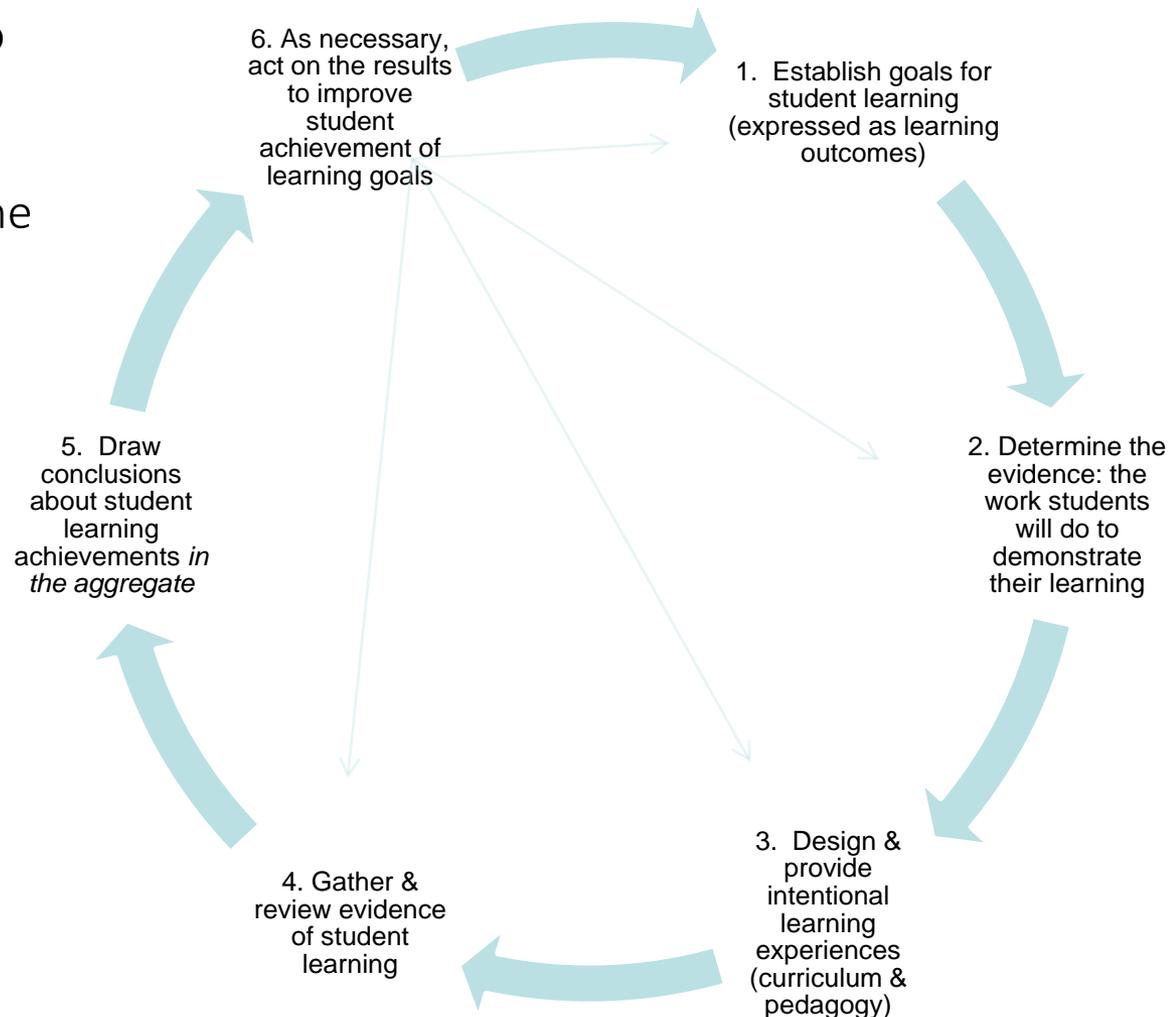
# Assessment as *pedagogy*

*Instructional activities* selected to

- facilitate development of and
- to reveal (to the teacher and the students)

student learning in relation to instructional goals.

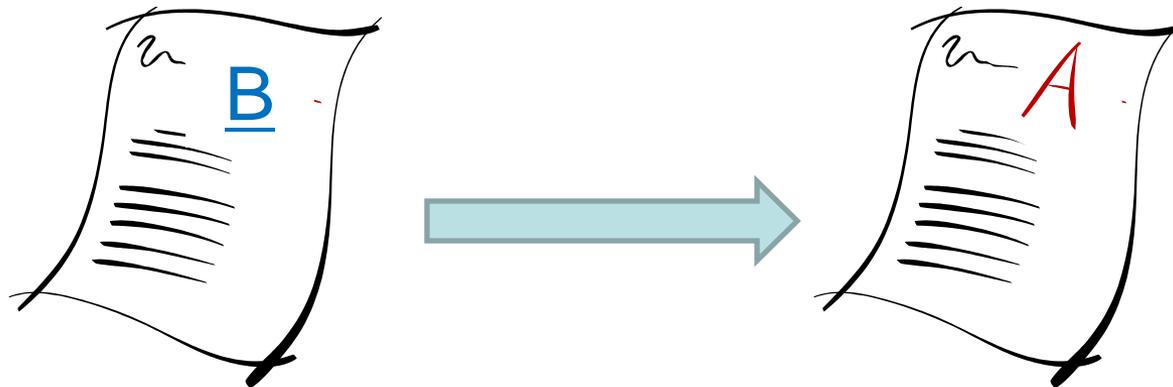
- ✓ Evidence of student learning is abundant.
- ✓ Harvest it intentionally and strategically.





# Relationship of grading & assessment

**Grading** : Summarizes learning demonstrated by an *individual* student, with feedback providing insight into and supporting his/her *individual* learning





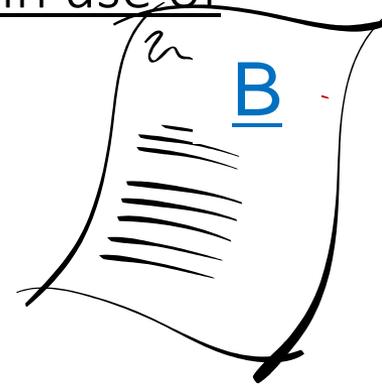
# Relationship of grading & assessment

**Assessment:** Summarizes learning demonstrated by a *population* of students to provide insights into how well the educational opportunity (class, course, program) is serving students as a whole

Ex. *What might this tell us?*

Results from a mid-semester research paper

- 60% of students scored as proficient or better in use of citations and evidence in argument
- 40% scored below proficient





# Assessment is “teaching to the test” (Suskie, 2009)

## Requires

- Assessments that are designed to be worth teaching to
- Intended learning outcomes that are higher level
- Opportunities for practice with specific, targeted feedback to students on what doing well, and what to improve

# Essentially assessment is a form of research

## Assessment paradigm

- Outcome
- Instructional Activities/Curriculum
- Collect & analyze evidence of student learning. Draw conclusions, revise instruction or outcomes.

## Research paradigm

- Hypothesis: what students will be able to do
- Experimental Design
- Gather data and draw conclusions about hypothesis





# Assessment is “action research” (Suskie, 2009)

## Assessment as Action Research\*

- Specific to local environment & student body
- Intended for local improvement
- Data/evidence are sufficiently valid and reliable so as to be “good enough,” “trustworthy enough” to act on

## Empirical Research

- Pursue generalizable results (theories)
- High quality design and data to meet test of peer review



# Classroom Assessment Techniques (CATs)

- Minute Paper
- Chain Notes
- Memory Matrix
- Directed paraphrasing
- One sentence summary
- Exam Evaluations
- Application cards
- Student-generated test questions



Angelo, T.A. and Cross, K.P. (1993). *Classroom Assessment Technologies* (Second Edition). San Francisco: Jossey-Bass Publishers.

# Large and Small Classes Assessment Tools

**Creating:** Group work

**Evaluating:** Debate

**Analyzing :** Clicker questions

**Applying:** Student Presentations – Pop quizzes

**Understanding:** Role playing / Just- in- time teaching

**Remembering:** Memory Matrix



The George Washington University: <http://tlc.provost.gwu.edu/classroom-assessment-techniques>



# Challenges to Implementing Interactive Activities

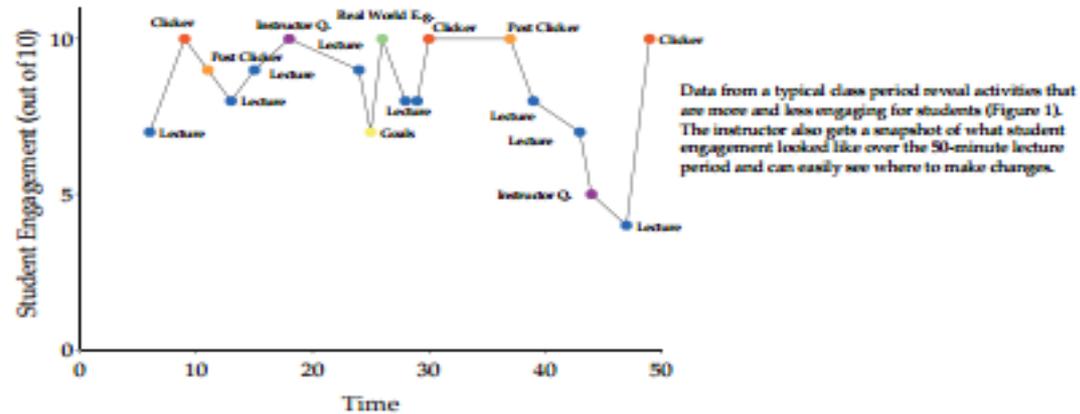
- Students resistance to participation (e.g. stop coming to class, start discussing their weekend plans)
- Expectations of content coverage
- Lack of instruction/instructor time
- Class size, or room layout
- Influence on teaching evaluations
- Additional time for curriculum (re)design

Quantifying student behavioral engagement based on teaching practices in a large class

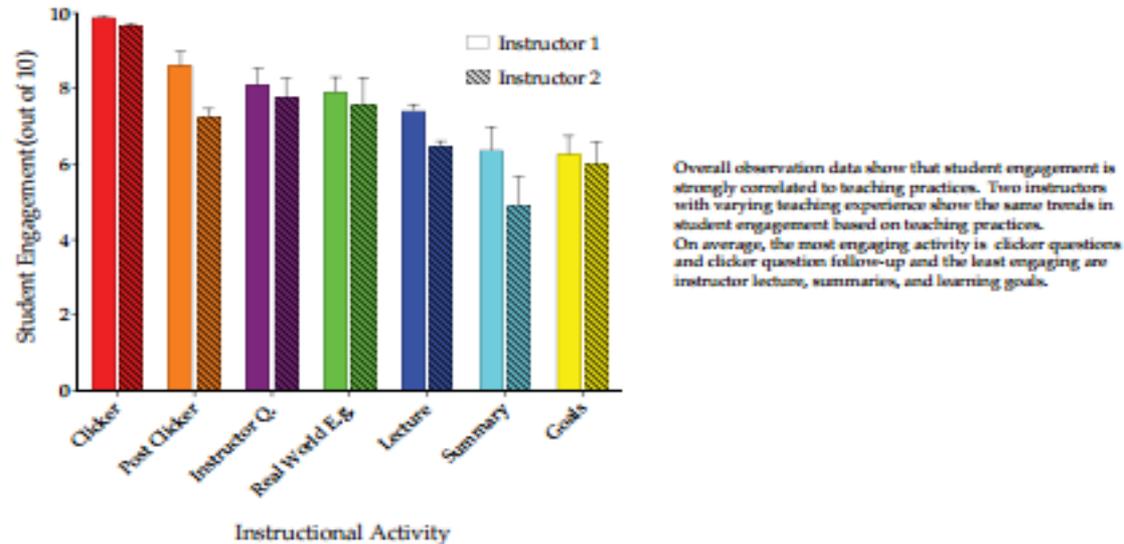
**Results from a large introductory oceanography course:**

Classroom observations were conducted during 27 lectures in a first year Oceanography course with an enrollment of 170 students and two course instructors. The observer sat in one of nine sections in the classroom, and obtained observations from each section at least three times in the semester. A total of 720 engagement observation points were recorded through the semester.

**Figure 1: Student engagement over a lecture period based on teaching activities**



**Figure 2: Student engagement based on instructional activity averaged over the semester for each instructor**



## Quantifying student behavioral engagement based on teaching practices in a large class

**TABLE 1**

**Descriptions of student in-class behaviors that indicate they are engaged.**

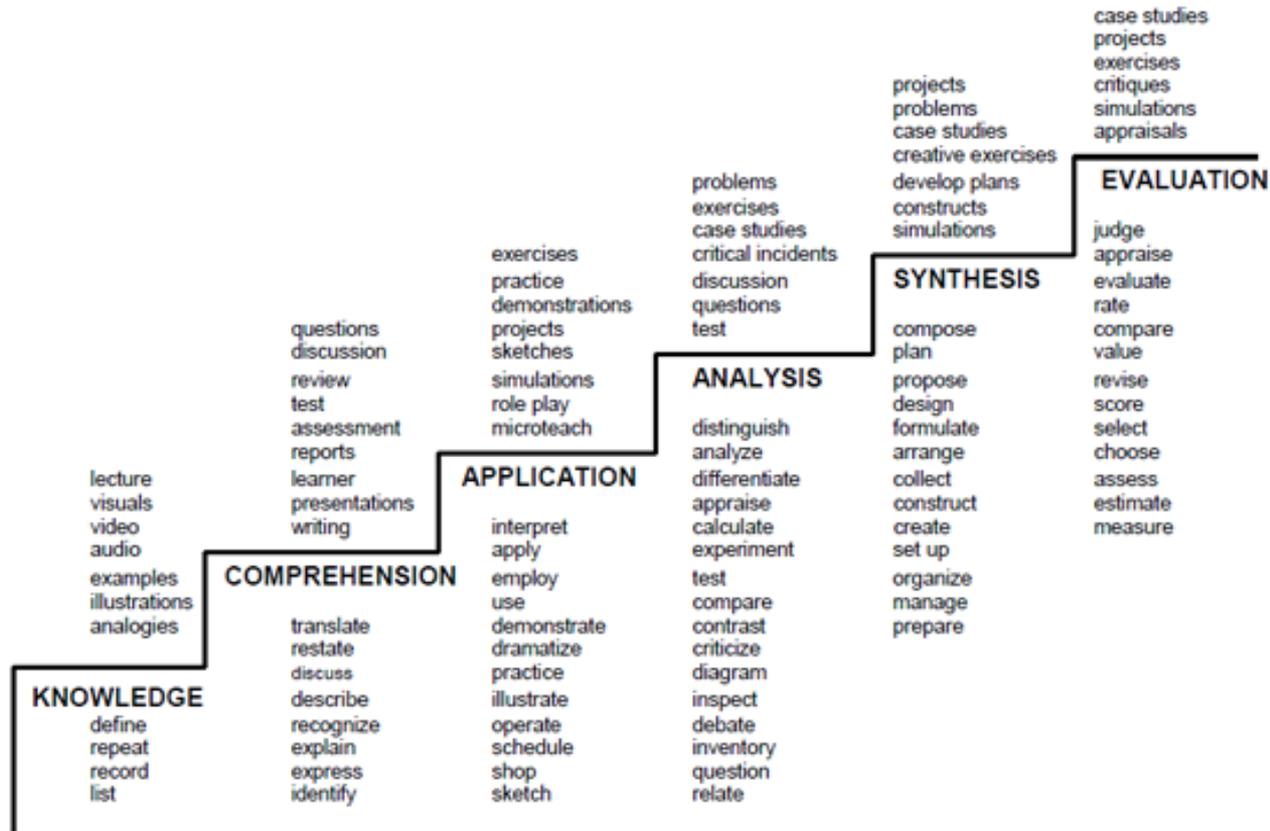
<b>Engaged</b>	
<b>Listening</b>	Student is listening to lecture. Eye contact is focused on the instructor or activity and the student makes appropriate facial expressions, gestures, and posture shifts (i.e., smiling, nodding in agreement, leaning forward).
<b>Writing</b>	Student is taking notes on in-class material, the timing of which relates to the instructor's presentation or statements.
<b>Reading</b>	Student is reading material related to class. Eye contact is focused on and following the material presented in lecture or preprinted notes. When a question is posed in class, the student flips through their notes or textbook.
<b>Engaged computer use</b>	Student is following along with lecture on computer or taking class notes in a word processor or on the presentation. Screen content matches lecture content.
<b>Engaged student interaction</b>	Student discussion relates to class material. Student verbal and nonverbal behavior indicates he or she is listening or explaining lecture content. Student is using hand gestures or pointing at notes or screen.
<b>Engaged interaction with instructor</b>	Student is asking or answering a question or participating in an in-class discussion.

**TABLE 2**

**Descriptions of student in-class behaviors that indicate they are disengaged.**

<b>Disengaged</b>	
<b>Settling in/ packing up</b>	Student is unpacking, downloading class material, organizing notes, finding a seat, or packing up and leaving classroom.
<b>Unresponsive</b>	Student is not responsive to lecture. Eyes are closed or not focused on instructor or lecture material. Student is slouched or sleeping, and student's facial expressions are unresponsive to instructor's cues.
<b>Off-task</b>	Student is working on homework or studying for another course, playing with phone, listening to music, or reading non-class-related material.
<b>Disengaged computer use</b>	Student is surfing web, playing game, chatting online, checking e-mail.
<b>Disengaged student interaction</b>	Student discussion does not relate to class material.
<b>Distracted by another student</b>	Student is observing other student(s) and is distracted by an off-task conversation or by another student's computer or phone.

Suggested Instructional Strategies for Use with Each Level of Bloom's Taxonomy





# Learning Outcomes

By the end of this session, you'll be able to ...

- Describe some elements of the learning cycle presented.
- List some classroom assessment tools which you are not using but could improve learning in your courses
- Identify the benefits of interactive-engagement and dare to give these activities a try.

# Resources

- Assessment at UC Merced: <http://assessment.ucmerced.edu/>

This website provides assessment related information for academic and non-academic program on campus.

- Carl Wieman Science Education Initiative at the University of British Columbia: <http://cwsei.ubc.ca/>

Resources aim at improving undergraduate science education. Consider the following tools: [Classroom Observation Protocol](#), [Teaching Practices Inventory](#), [Student Engagement Observation Protocol](#) and [Learning Attitudes about Science Surveys](#)

- Writing Great Clicker Questions: [Faculty Workshop](http://cwsei.ubc.ca/resources/faculty-workshop) cwsei.ubc.ca/resources/
- Resources by Discipline: University of Michigan, CRLT: <http://www.crlt.umich.edu/tstrategies/disciplinaryresources>
- CRTE: Teaching Resources: <http://crte.ucmerced.edu/>
- SATAL Program: Offer trained undergraduates who can assist you with data collection, analyzes and reporting.

## Many thanks to....

- Laura Martin for sharing the assessment cycle slides
- Belinda Braunstein's feedback during presentation rehearsal.



# 25+ question stems framed around the early, non-revised Bloom's Taxonomy

## CRITICAL THINKING SKILLS

<b>1</b> <b>Knowledge</b>  Identification and recall of information	define fill in the blank list identify	label locate match memorize	name recall spell	state tell underline
	Who _____? What _____? Where _____? When _____?		How _____? Describe _____? What is _____?	
<b>2</b> <b>Comprehension</b>  Organization and selection of facts and ideas	convert describe explain	interpret paraphrase put in order	restate retell in your own words rewrite	summarize trace translate
	Re-tell _____ in your own words. What is the main idea of _____?		What differences exist between _____? Can you write a brief outline?	
<b>3</b> <b>Application</b>  Use of facts, rules, and principles	apply compute conclude construct	demonstrate determine draw find out	give an example illustrate make operate	show solve state a rule or principle use
	How is _____ an example of _____? How is _____ related to _____? Why is _____ significant?		Do you know of another instance where _____? Could this have happened in _____?	
<b>4</b> <b>Analysis</b>  Separating a whole into component parts	analyze categorize classify compare	contrast debate deduct determine the factors	diagram differentiate dissect distinguish	examine infer specify
	What are the parts or features of _____? Classify _____ according to _____. Outline/diagram/web/map _____.		How does _____ compare/contrast with _____? What evidence can you present for _____?	
<b>5</b> <b>Synthesis</b>  Combining ideas to form a new whole	change combine compose construct create design	find an unusual way formulate generate invent originate plan	predict pretend produce rearrange reconstruct reorganize	revise suggest suppose visualize write
	What would you predict/infer from _____? What ideas can you add to _____? How would you create/design a new _____?		What solutions would you suggest for _____? What might happen if you combined _____ with _____?	
<b>6</b> <b>Evaluation</b>  Developing opinions, judgements, or decisions	appraise choose compare conclude	decide defend evaluate give your opinion	judge justify prioritize rank	rate select support value
	Do you agree that _____? Explain. What do you think about _____? What is most important?		Prioritize _____ according to _____? How would you decide about _____? What criteria would you use to assess _____?	

**Knowledge**

**Comprehension**

**Application**

**Analysis**

**Synthesis**

**Evaluation**

Recall /regurgitate facts without understanding. Exhibits previously learned material by recalling facts, terms, basic concepts and answers.

To show understanding finding information from the text. Demonstrating basic understanding of facts and ideas.

To use in a new situation. Solving problems by applying acquired knowledge, facts, techniques and rules in a different way.

To examine in detail. Examining and breaking information into parts by identifying motives or causes; making inferences and finding evidence to support generalisations.

To change or create into something new. Compiling information together in a different way by combining elements in a new pattern or proposing alternative solutions.

To justify. Presenting and defending opinions by making judgements about information, validity of ideas or quality of work based on a set of criteria.

**Key words:**

Choose	Observe	Show
Copy	Omit	Spell
Define	Quote	State
Duplicate	Read	Tell
Find	Recall	Trace
How	Recite	What
Identify	Recognise	When
Label	Record	Where
List	Relate	Which
Listen	Remember	Who
Locate	Repeat	Why
Match	Reproduce	Write
Memorise	Retell	
Name	Select	

**Key words:**

Ask	Extend	Outline
Cite	Generalise	Predict
Classify	Give examples	Purpose
Compare	Relate	
Contrast	Illustrate	Rephrase
Demonstrate	illustrate	Report
Discuss	Indicate	Restate
Estimate	Infer	Review
Explain	Interpret	Show
Express	Match	Summarise
	Observe	Translate

**Key words:**

Act	Employ	Practice
Administer	Experiment	Relate
Apply	with	Represent
Associate	Group	Select
Build	Identify	Show
Calculate	Illustrate	Simulate
Categorise	Interpret	Solve
Choose	Interview	Summarise
Classify	Link	Teach
Connect	Make use of	Transfer
Construct	Manipulate	Translate
Correlation	Model	Use
Demonstrate	Organise	
Develop	Perform	
Dramatise	Plan	

**Key words:**

Analyse	Examine	Prioritize
Appraise	Find	Question
Arrange	Focus	Rank
Assumption	Function	Reason
Breakdown	Group	Relationships
Categorise	Highlight	
Cause and effect	In-depth discussion	Reorganise
Choose	Inference	Research
Classify	Inspect	See
Differences	Investigate	Select
Discover	Isolate	Separate
Discriminate	List	Similar to
Dissect	Motive	Simplify
Distinction	Omit	Survey
Distinguish	Order	Take part in
Divide	Organise	Test for
Establish	Point out	Theme
		Comparing

**Key words:**

Adapt	Estimate	Plan
Add to	Experiment	Predict
Build	Extend	Produce
Change	Formulate	Propose
Choose	Happen	Reframe
Combine	Hypothesise	Revise
Compile	Imagine	Rewrite
Compose	Improve	Simplify
Construct	Innovate	Solve
Convert	Integrate	Speculate
Create	Invent	Substitute
Delete	Make up	Suppose
Design	Maximise	Tabulate
Develop	Minimise	Test
Devise	Model	Theorise
Discover	Modify	Think
Discuss	Original	Transform
Elaborate	Originate	Visualise

**Key words:**

Agree	Disprove	Measure
Appraise	Dispute	Opinion
Argue	Effective	Perceive
Assess	Estimate	Persuade
Award	Evaluate	Prioritise
Bad	Explain	Prove
Choose	Give reasons	Rate
Compare	Good	Recommend
Conclude	Grade	Rule on
Consider	How do we know?	Select
Convince	Importance	Support
Criteria	Infer	Test
Criticism	Influence	Useful
Debate	Interpret	Validate
Decide	Judge	Value
Deduct	Justify	Why
Defend	Determine	Mark

**Actions:**

Describing  
Finding  
Identifying  
Listing  
Locating  
Naming  
Recognising  
Retrieving

**Outcomes:**

Definition  
Fact  
Label  
List  
Quiz  
Reproduction  
Test  
Workbook  
Worksheet

**Actions:**

Classifying  
Comparing  
Exemplifying  
Explaining  
Inferring  
Interpreting  
Paraphrasing  
Summarising

**Outcomes:**

Collection  
Examples  
Explanation  
Label  
List  
Outline  
Quiz  
Show and tell  
Summary

**Actions:**

Carrying out  
Executing  
Implementing  
Using

**Outcomes:**

Demonstration  
Diary  
Illustrations  
Interview  
Journal  
Performance  
Presentation  
Sculpture  
Simulation

**Actions:**

Attributing  
Deconstructing  
Integrating  
Organising  
Outlining  
Structuring

**Outcomes:**

Abstract  
Chart  
Checklist  
Database  
Graph  
Mobile  
Report  
Spread sheet  
Survey

**Actions:**

Constructing  
Designing  
Devising  
Inventing  
Making  
Planning  
Producing

**Outcomes:**

Advertisement  
Film  
Media product  
New game  
Painting  
Plan  
Project  
Song  
Story

**Actions:**

Attributing  
Checking  
Deconstructing  
Integrating  
Organising  
Outlining  
Structuring

**Outcomes:**

Abstract  
Chart  
Checklist  
Database  
Graph  
Mobile  
Report  
Spread sheet  
Survey

**Questions:**

Can you list three ...?  
Can you recall ...?  
Can you select ...?  
How did \_\_\_\_\_ happen?  
How is ...?  
How would you describe ...?  
How would you explain ...?  
How would you show ...?  
What is ...?  
When did ...?  
When did \_\_\_\_\_ happen?  
Where is ...?  
Which one ...?  
Who was ...?  
Who were the main ...?  
Why did ...?

**Questions:**

Can you explain what is happening ... what is meant ...?  
How would you classify the type of ...?  
How would you compare ...?contrast ...?  
How would you rephrase the meaning ...?  
How would you summarise ...?  
What can you say about ...?  
What facts or ideas show ...?  
What is the main idea of ...?  
Which is the best answer ...?  
Which statements support ...?  
Will you state or interpret in your own words ...?

**Questions:**

How would you use...?  
What examples can you find to ...?  
How would you solve \_\_\_\_\_ using what you have learned ...?  
How would you organise \_\_\_\_\_ to show ...?  
How would you show your understanding of ...?  
What approach would you use to...?  
How would you apply what you learned to develop ...?  
What other way would you plan to ...?  
What would result if ...?  
Can you make use of the facts to ...?  
What elements would you choose to change ...?  
What facts would you select to show ...?  
What questions would you ask in an interview with ...?

**Questions:**

What are the parts or features of ...?  
How is \_\_\_\_\_ related to ...?  
Why do you think ...?  
What is the theme ...?  
What motive is there ...?  
Can you list the parts ...?  
What inference can you make ...?  
What conclusions can you draw ...?  
How would you classify ...?  
How would you categorise ...?  
Can you identify the difference parts ...?  
What evidence can you find ...?  
What is the relationship between ...?  
Can you make a distinction between ...?  
What is the function of ...?  
What ideas justify ...?

**Questions:**

What changes would you make to solve...?  
How would you improve ...?  
What would happen if...?  
Can you elaborate on the reason...?  
Can you propose an alternative...?  
Can you invent...?  
How would you adapt \_\_\_\_\_ to create a different...?  
How could you change (modify) the plot (plan)...?  
What could be done to minimise (maximise)...?  
What way would you design...?  
Suppose you could \_\_\_\_\_ what would you do...?  
How would you test...?  
Can you formulate a theory for...?  
Can you predict the outcome if...?  
How would you estimate the results for...?  
What facts can you compile...?  
Can you construct a model that would change...?  
Can you think of an original way for the ...?

**Questions:**

Do you agree with the actions/outcomes...?  
What is your opinion of...?  
How would you prove/disprove...?  
Can you assess the value/importance of...?  
Would it be better if...?  
Why did they (the character) choose...?  
What would you recommend...?  
How would you rate the...?  
What would you cite to defend the actions...?  
How would you evaluate ...?  
How could you determine...?  
What choice would you have made...?  
What would you select...?  
How would you prioritise...?  
What judgement would you make about...?  
Based on what you know, how would you explain...?  
What information would you use to support the view...?  
How would you justify...?  
What data was used to make the conclusion...?

**Bloom's Taxonomy:**

Questions framed around Categories

# Students at a variety of achievement levels may inform the class outcomes



A students: verify that students get the right answer for the right reasons

B and C students: retain some misunderstandings that are useful as distracters

D students: look for non-content clues to the right answer

# Example of Learning Outcomes

<i>UC Merced Principles</i>	<i>Course Goals</i>	<i>Course Learning Outcomes</i>	<i>Assessment</i>
Scientific Literacy	To provide an introduction to the field of social epidemiology, the major theories, concepts, and perspectives.	<b>Describe</b> how social and environmental factors affect health outcomes, including how risk factors are arrayed across different social conditions.	Term paper, exams, reading summaries, quizzes
Scientific Literacy Communication	To learn how health outcomes and risk factors are arrayed across different social conditions and social systems.	(a) <b>Integrate</b> different perspectives, research, and skills discussed in class to explain group differences in health and well-being. (b) In writing, clearly <b>analyze</b> these differences in health and well-being.	Term paper, exams, reading summaries

# Active Learning “Works”... What Are We Measuring?

- Factual knowledge
- Transferable problem solving skills (Hake, R. 1997)
- Relevant skills
- Students’ attitudes
- Student retention



# Biology CLASS statements designed to distinguish novice and expert beliefs

## Survey (8-10 minutes)

1. When I am solving a biology problem, I try to decide if my answer makes sense.

Strongly Disagree 1 2 3 4 5 Strongly Agree

not answered

Likert scale

2. I think about the biology I experience in everyday life.

Strongly Disagree 1 2 3 4 5 Strongly Agree

not answered

3. After I study a topic in biology and feel that I understand it, I have difficulty applying that information to answer questions on the same topic.

Strongly Disagree 1 2 3 4 5 Strongly Agree

not answered

4. Knowledge in biology consists of many disconnected topics.

Strongly Disagree 1 2 3 4 5 Strongly Agree

not answered

- Statements are based on the physics CLASS (Adams *et al.*, 2004)
- Student interviews on statements were conducted for clarity of interpretation (n=15)
- Experts have 80% or greater agreement on 34 of 44 statements
- Student responses are compared with experts

# Example of a learning outcome

Syllabus topic: Pedigree Analysis

Example of a course learning outcome

After completing this course, students should be able to:

Analyze phenotypic data and deduce possible modes of inheritance (e.g. dominant, recessive, autosomal, X-linked, cytoplasmic) from family histories.

Sample of class learning outcomes

Draw a pedigree based on information in a story problem.

Calculate the probability that an individual in a pedigree has a particular genotype.

Define the terms “incomplete penetrance,” “variable expressivity,” and “sex-limited phenotype,” and explain how these phenomena can complicate pedigree analysis.

# The pre/post assessment is different from other tests

Assessment could be multiple-choice questions that address the course learning outcomes.

Jargon is used minimally in this assessment.

Assessment is given pre and post to measure learning gains.

The incorrect answers are designed to be attractive to students who do not fully understand the concepts.



# Differences between novice and expert learners concerning their beliefs about science

<b>Novice</b>		<b>Expert</b>
Isolated pieces of information	<b><u>content and structure</u></b>	Coherent framework of concepts
Handed down by authority No connection to the real world	<b><u>source</u></b>	Describes nature Established by experiments
Pattern matching to memorized recipes	<b><u>problem solving</u></b>	Use concept-based strategies. Widely applicable.

(adapted from David Hammer, 2000).

# Planning cycle applicable at any learning experience

- ✓ Given day's class
- ✓ Course
- ✓ Degree Program

