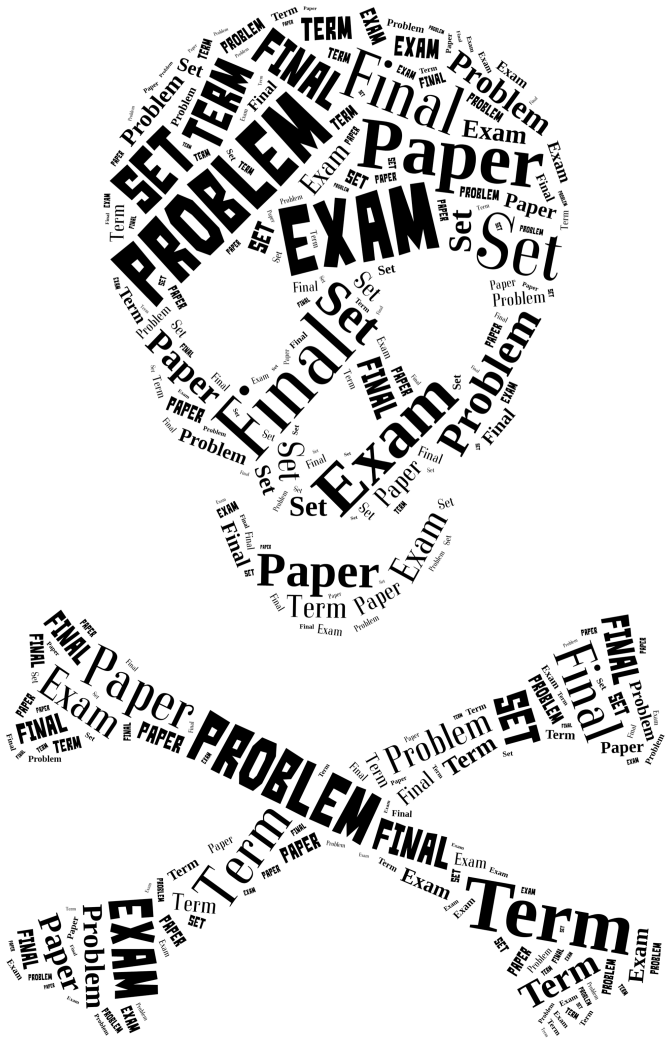
Best Practices to Evaluate Student Learning



Preceptor in Biological Chemistry | Marty Samuels
Lecturer in Biological Sciences at Northwestern University | Stanley Lo
Lecturer in Neurobiology | Ryan Draft

Best Practices to Evaluate Student Learning

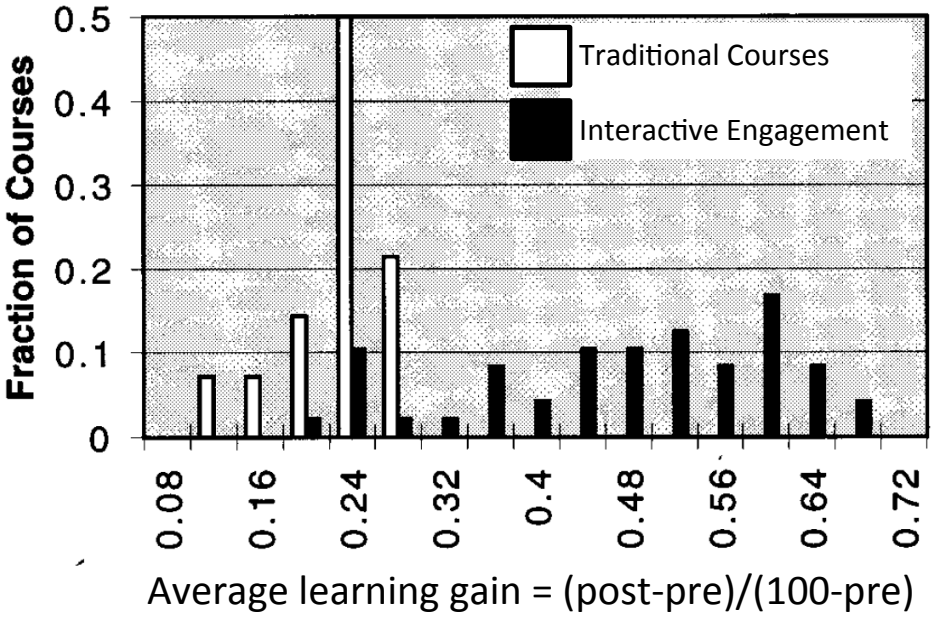
GOAL: Teach you to use assessment to teach better.

OBJECTIVES:

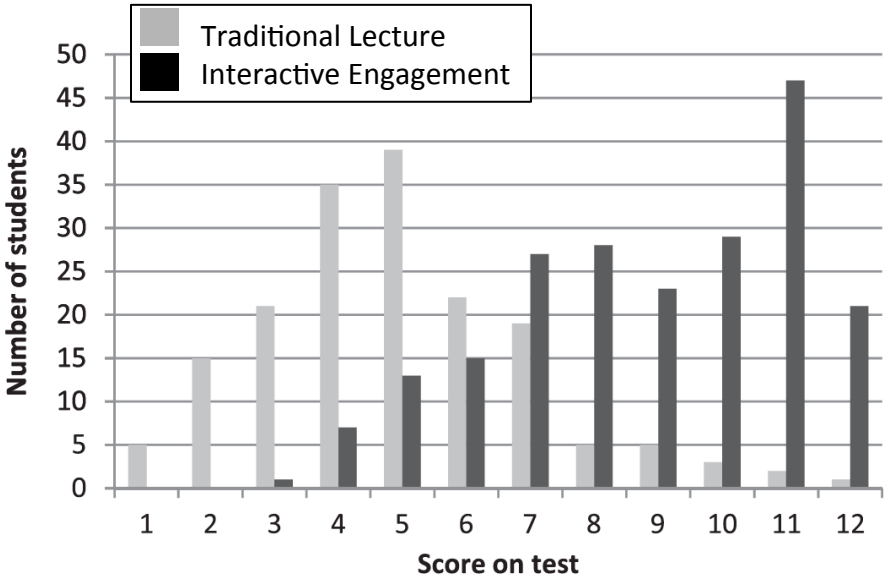
1. To understand how feedback and reflection can increase self-learning.
2. To employ group learning to help students evaluate themselves.
3. To be able to write questions that evaluate different levels of understanding.
4. To understand your role in connecting lecture with graded assignments.

Active Learning Can Increase Learning

62 courses, **6452** physics students testing interactive strategies *vs.* traditional lecture



538 students split into a traditional lecture group and a deliberative practice group.



Hake et al, *Am. J. Phys*. 1998.
Deslariers et al, *Science* 2011.

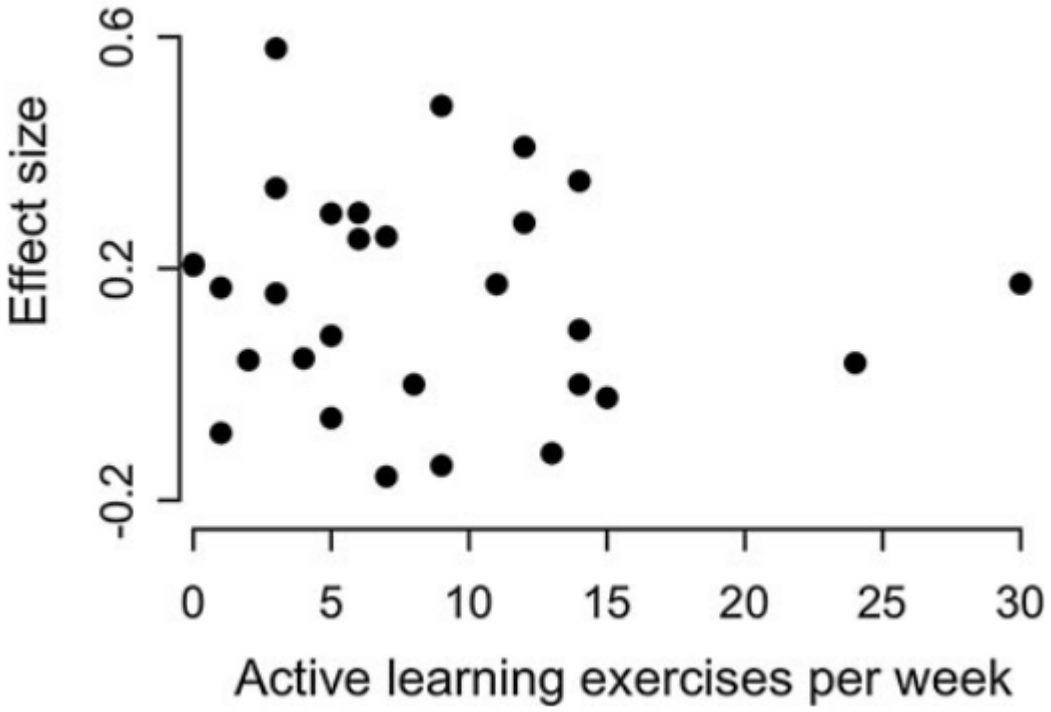
Active Learning Exercise 1: Reflection and Feedback

pH Strip/Titration activity

Active Learning Can Increase learning … maybe?

33 instructors and courses
pre/post assessment on evolution concepts

$$\frac{\text{(Post-Pre)}}{SD_{pre}}$$



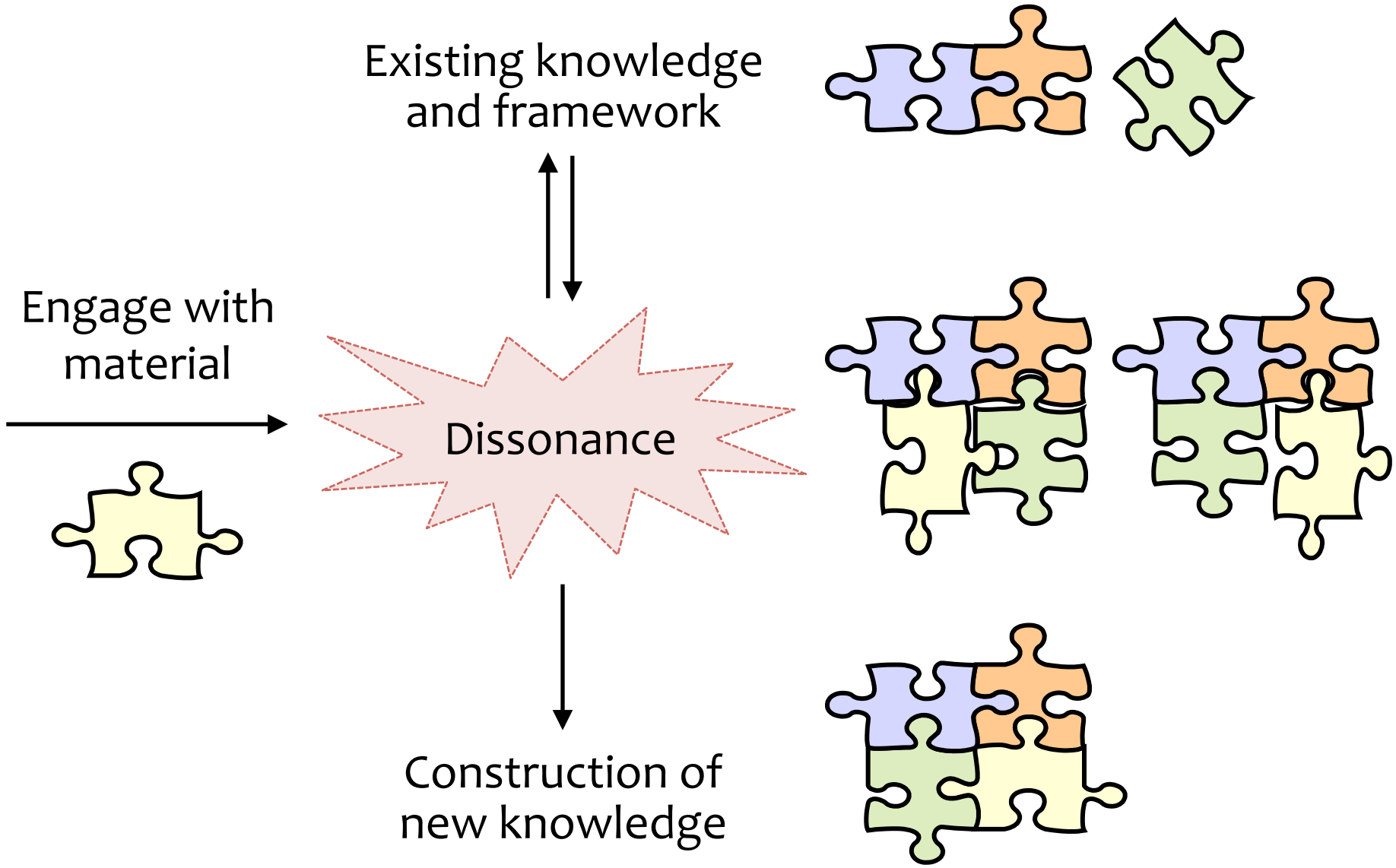
CBE Life Sciences Education (2011) 10: 394-405

What Makes Active Learning Work (or not)?

In your group, think about what factors might underlie the variation in active learning gains.



How People Learn



NSF (2002) *Foundations: A Monograph for Professionals in STEM Education*

Active Learning Exercise 2

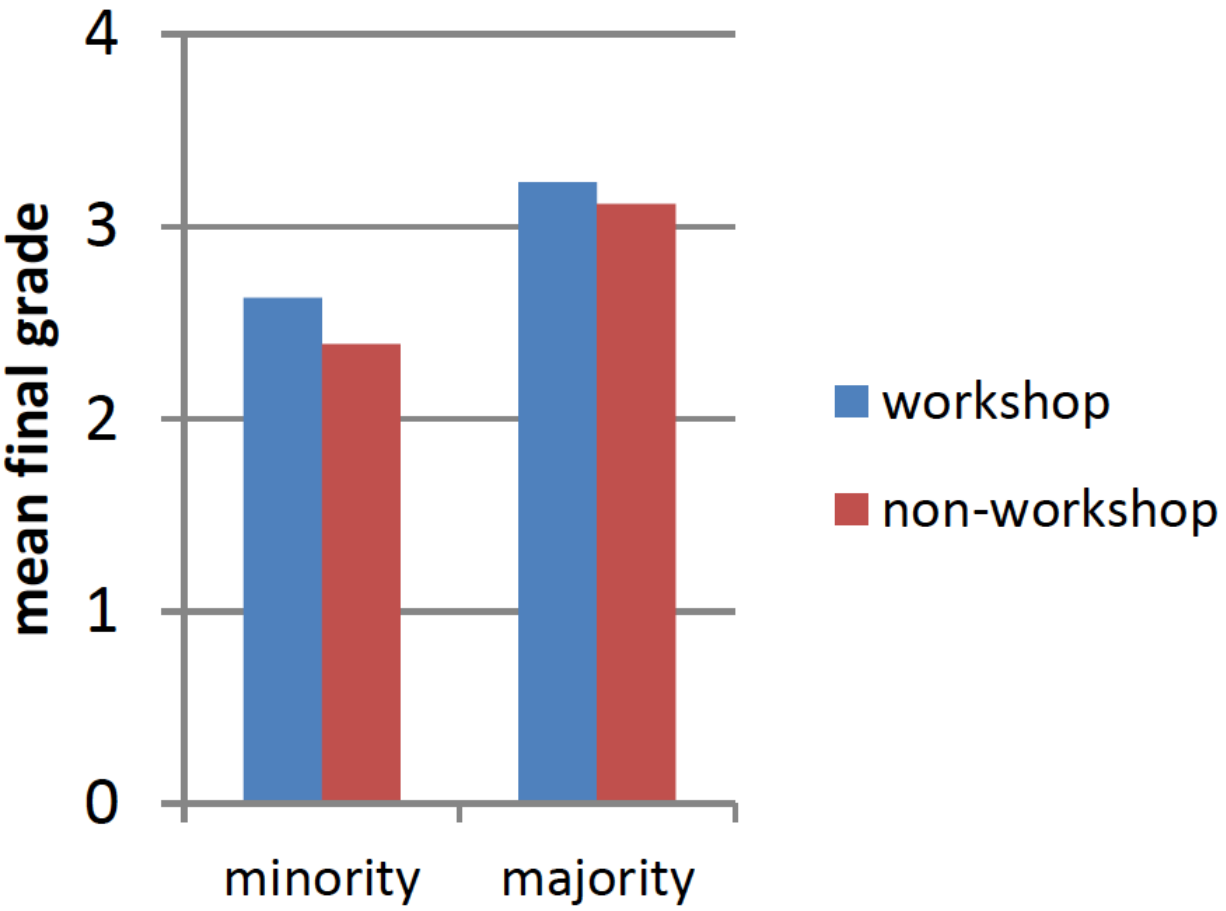
Amino Acid Statement Correction

- Work 2 minutes alone
- Then work with your group

Group Feedback is Crucial for Learning

Study of small group learning

- 10 year study across STEM disciplines

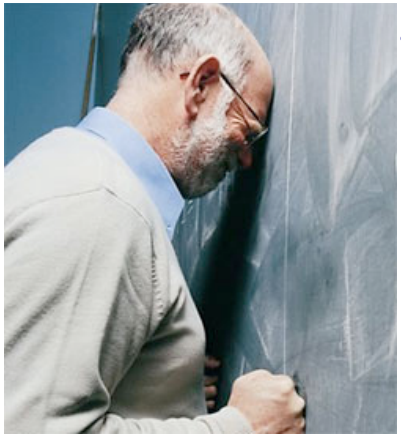


J Sci Ed and Tech(2005) 14:3

Activity 2 Debrief: Using Feedback

In your groups, please discuss the following question:

How did this activity allow for evaluation?



Teacher:

- Identify student knowledge/skill deficiencies
- Modify subsequent learning activities
- Focus away from grading ☹ and onto learning ☺



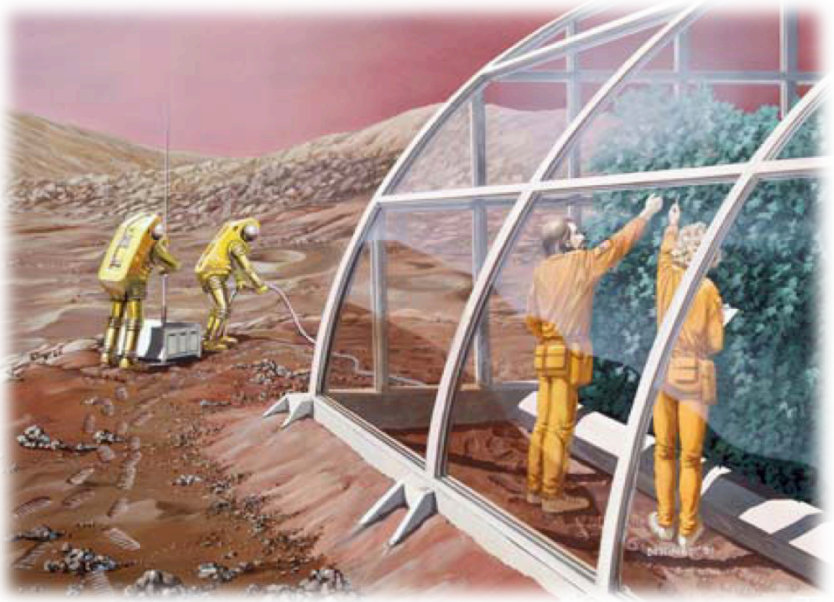
Student:

- Clarify what good performance is (goals, expected standards)
- Assess their own knowledge/skills
- Assess their peers' knowledge/readiness
- Promotes the development of self-assessment

The Montillation and Use of Traxoline

It is very important to learn about traxoline. Traxoline is a new form of zionter. It is montilled in Ceristanna. The Ceristannians found that they could gristerlate large amounts of fervon and then bracter it to quasel traxoline. This new, more efficient bracterillation process has the potential to make traxoline one of the most useful products within the molecular family of lukizes snezlaus.

1. What is traxoline?
2. Where is it montilled?
3. How is traxoline quaseled?
4. Why is traxoline important?

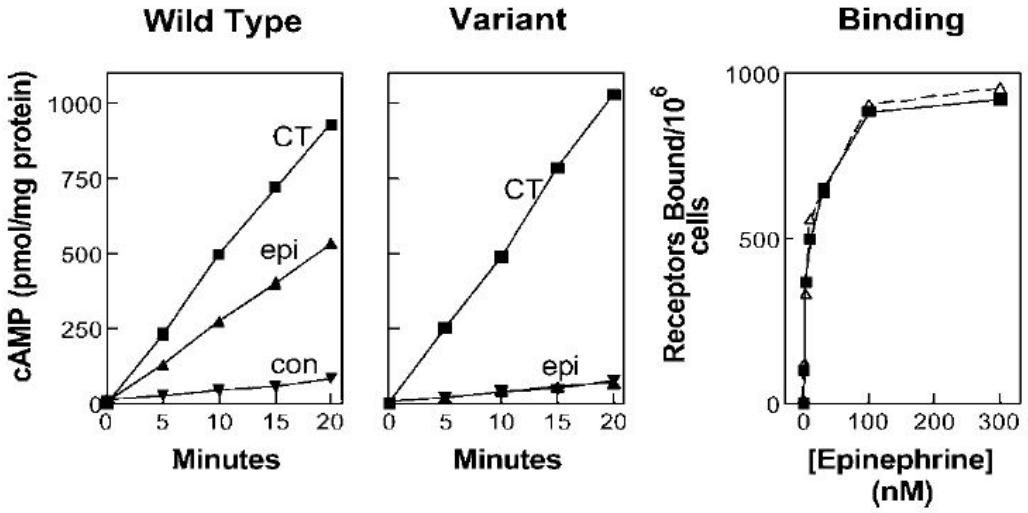


What Types of Thinking are Involved?

A. The function of the GTPase activity of G-proteins is: _____

B. Cholera toxin modifies the G-protein by transferring ADP-ribose to an arginine residue in the GTPase active site. What is the most likely outcome?

C. Based on the data, what mutation(s) are possible in the variant cells? Explain your reasoning.



Left and Center: Wild-type and variant cells were incubated with only GTP (con), with epinephrine and GTP (epi), or with cholera toxin and GTP (CT).
Right: Binding of radioactive epinephrine to wild-type (solid squares) and variant cells (triangles).

Cell Biology Education (2003) 2: 180-194.

Bloom's Taxonomy of Cognitive Processes

Remember	Recalling information Recognizing, listing, describing, retrieving, naming, finding
Understand	Explaining ideas or concepts Interpreting, summarizing, paraphrasing, classifying, explaining
Apply	Using information in another familiar situation Implementing, carrying out, using, executing
Analyze	Breaking information into parts to explore relationships Comparing, organizing, deconstructing, interrogating, finding
Evaluate	Judging based on criteria Experimenting, checking, hypothesizing, critiquing, justifying
Create	Generating new ideas, products, or ways of viewing things Designing, constructing, planning, producing, inventing

Anderson and Krathwohl (2001) *A Taxonomy for Learning, Teaching, and Assessing*

Active Learning Exercise 3: Higher Order Questions

Ribosome Strip Sequence

Activity 3 Debrief: Higher Order Questions

Work with your group to design a question that could test higher-order concepts for this activity.

Higher Order Questions Lead to Deeper Student Understanding, which Lasts Longer

Study of long-term conceptual understanding after deep (vs. superficial) questions:

- Compare test scores given in the middle of the course and at 8 to 101 weeks later

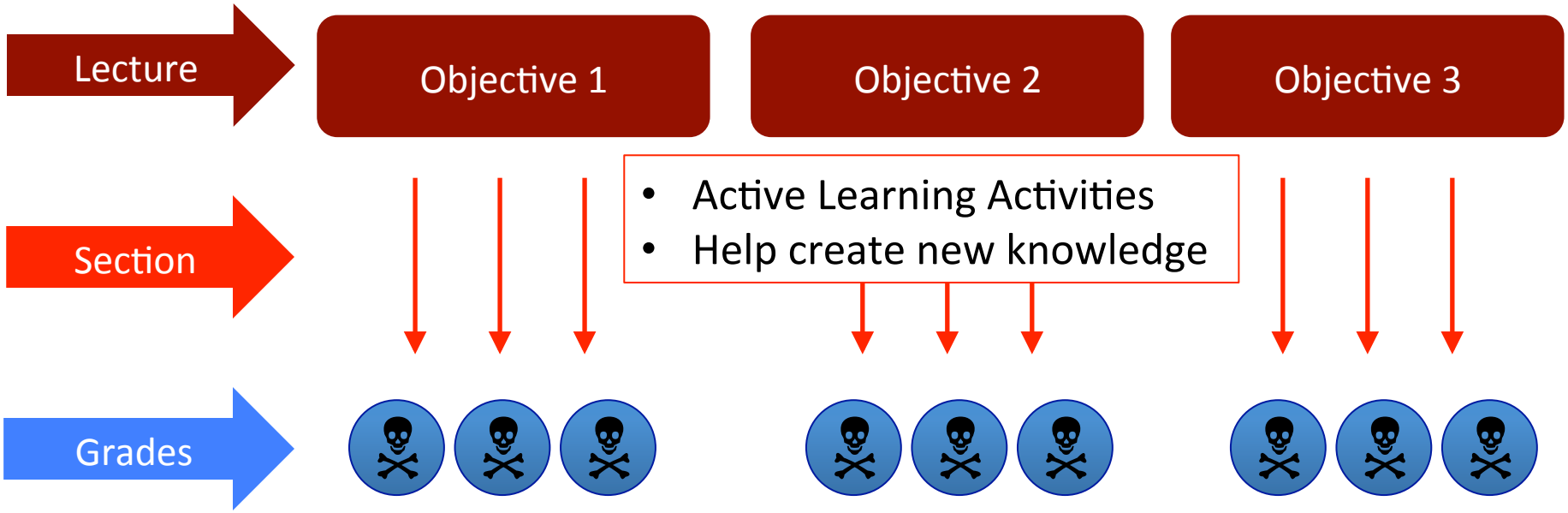
Subtest	M	*Difference*	*Pooled* SD	*Effect Size*	p
Deep	2.43	3.24	9.30	0.35	.01
Surface	–0.81				

1/3 of a grade better

Journal of Marketing Education (2006) **28**: 181-192

Your Role in Connecting to Lecture

Lecture Goals: We know the concepts and questions we want students to know and understand



- Tests, P-sets, Papers
- Demonstrate knowledge

Conclusion: Take Home Messages

1. Activities require **reflection/feedback** for maximal learning gains.

2. Group work provides essential feedback for the **student and teacher.**

3. Assessment questions should **span** higher and lower order levels of understanding.

4. You as a TF are crucial for **bridging and connecting** lecture with graded assignments.

Your Task for This Afternoon

1. Discuss your group's topic.
   - Agree on the context in which the activity could be taught.
   - What particular areas of the topic might be challenging?

2. Write learning goals and objectives for your topic.

3. Decide what you want the students to understand and be able to do to demonstrate their knowledge?

4. Develop a 15-minute teaching activity.

5. Teach the activity to another group:
   - 15 minutes of teaching
   - 15 minutes of feedback.

Impact of course innovations on learning

Published studies (n=166/310), average effect size = 0.47

$$ES = \frac{Avg_{(treatment)} - Avg_{(control)}}{SD_{(control)}}$$

0.54 1.31 0.90

0.47

Conceptually Oriented Tasks (COTs):

- elicit students' level of understanding of key science concepts;
- identify students' misconceptions, "common sense" knowledge at odds with actual concepts that are known to affect students' learning;
- engage students in conceptual schemes within a topic rather than isolated facts; help students focus on methods of problem representation and approaches to think about the problem components (solving strategies);
- engage students with real-world problems in creative ways that reflect a conceptually integrated understanding of the content

Technology (TECH):

- helps students visualize processes and/or concepts;
- helps students manipulate variables by collecting and/or analyzing data that can help them understand a concept or a process or solve real-world problems;
- helps students test theories and models with simulated data;
- provides feedback (online homework, such as problem sets).

0.37

0.68

Collaborative Learning (CL) Activities:

- engage students with peers (groups as small as pairs) as a component of the learning process;
- provide students the opportunity to engage in explanations and discussions as they describe their reasoning, interpretations, and solutions to problems.

Inquiry-Based Projects (IBPs):

- provide students the opportunity to undertake research projects (may or may not be in a real-world setting) that require more than one class period to complete;
- require students to develop a procedure and/or plan to complete the project;
- require students to follow a structured procedure and/or plan provided in advance as a framework to complete the project.

Science (2011) **331**: 1269-1270.

Activity 1 Debrief: Reflection

In your groups, please discuss the following question:

Do you think an activity like this would **increase retention** compared to a section review lecture or problem set?



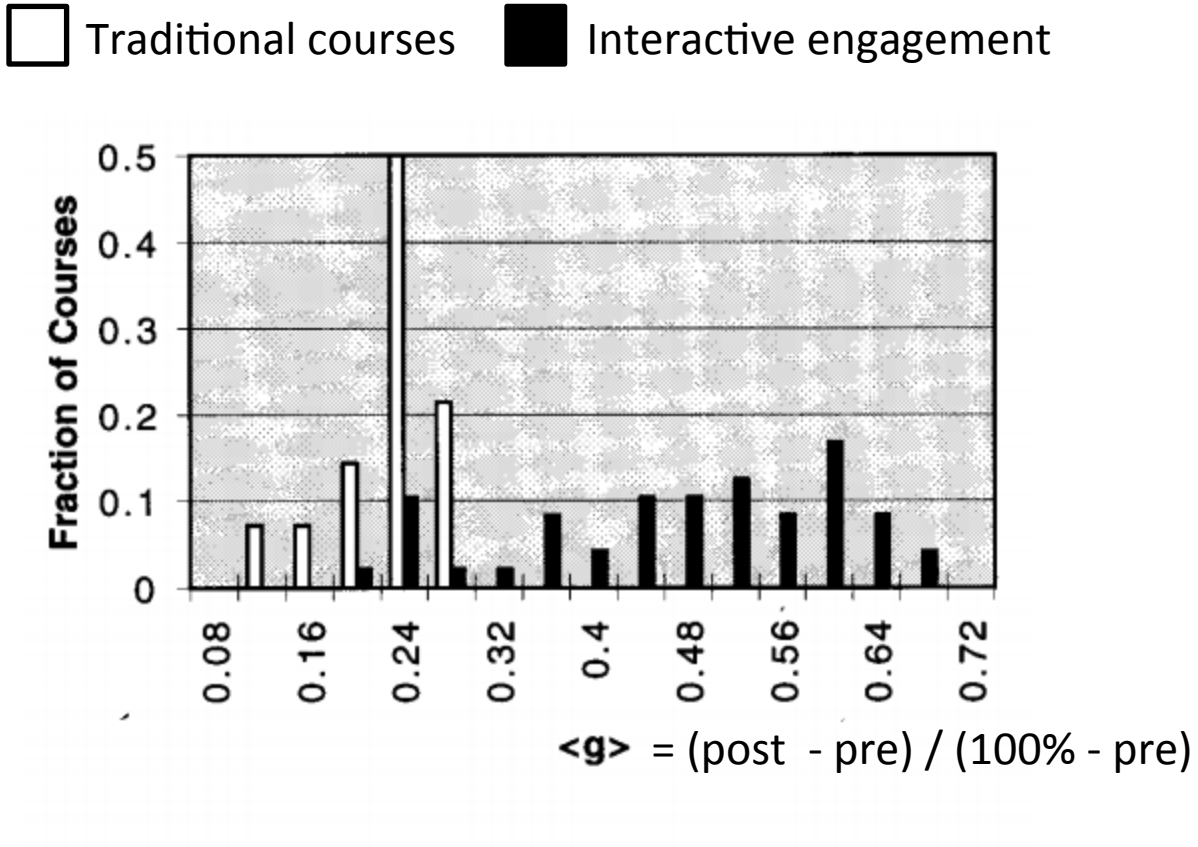


Fig. 2. Histogram of the average normalized gain $\langle g \rangle$: white bars show the *fraction* of 14 traditional courses ($N = 2084$), and black bars show the *fraction* of 48 interactive engagement courses ($N = 4458$), both within bins of width $\delta\langle g \rangle = 0.04$ centered on the $\langle g \rangle$ values shown.

Am J Phys (1998) 66: 64-74

Impact of course innovations on learning

EFFECT SIZES OF INNOVATIONS AND COMBINATIONS OF INNOVATIONS

Innovations	*n*	Mean	Median	SD
COTs	9	0.47	0.22	0.70
CL	5	0.68	0.69	0.16
TECH	30	0.37	0.38	0.38
COTs+CL	41	0.54	0.54	0.43
COTs+TECH	18	0.41	0.44	0.61
TECH+IBP	9	−0.11	−0.25	0.67
COTs+CL+TECH	39	0.46	0.50	0.50
Other	15	0.84	0.74	0.65
Total	166	0.47	0.47	0.54

"Other" refers to innovation combinations wherein fewer than five studies were combined. See SOM for details.

Science (2011) **331**: 1269-1270.

Every Activity Requires Reflection

- Explain answers and reasoning
- Discuss differing ideas
- Identify what was confusing
- Identify what you needed to know



How People Learn

PRIOR KNOWLEDGE

Engaging with the material

DISSONANCE

CONSTRUCTION OF NEW KNOWLEDGE



Foundations. Borasi and Fonzi, National Science Foundation.