Assessment in STEM
Teaching Science Like a Scientist

A. Malcolm Campbell

DAVIDSON

10 October, 2017
Hunter College

Key Points for Today

- Teaching as scholarship
- Examples of my assessment
- Change is needed
- Design course with assessment included
- Your turn to generate a plan for your course

Introductions

name
department and courses
workshop focus course

Malcolm Campbell
Biology and Genomics (24 years)

- Introductory Biology
- Genomics
- Lab Method in Genomics

Two Types of Assessment

Imposed from Above

http://a.abcnews.com/images/US/GTY_prison_guard_jt_140125_16x9_992.jpg

Do It for Yourself

http://upl.stack.com/wp-content/uploads/2013/11/KidLifting.jpg

Scholarship of Teaching

Would you write a paper without collecting data?

Would you start a new area of research without reading literature first?

Why do so many do both of these in their careers?

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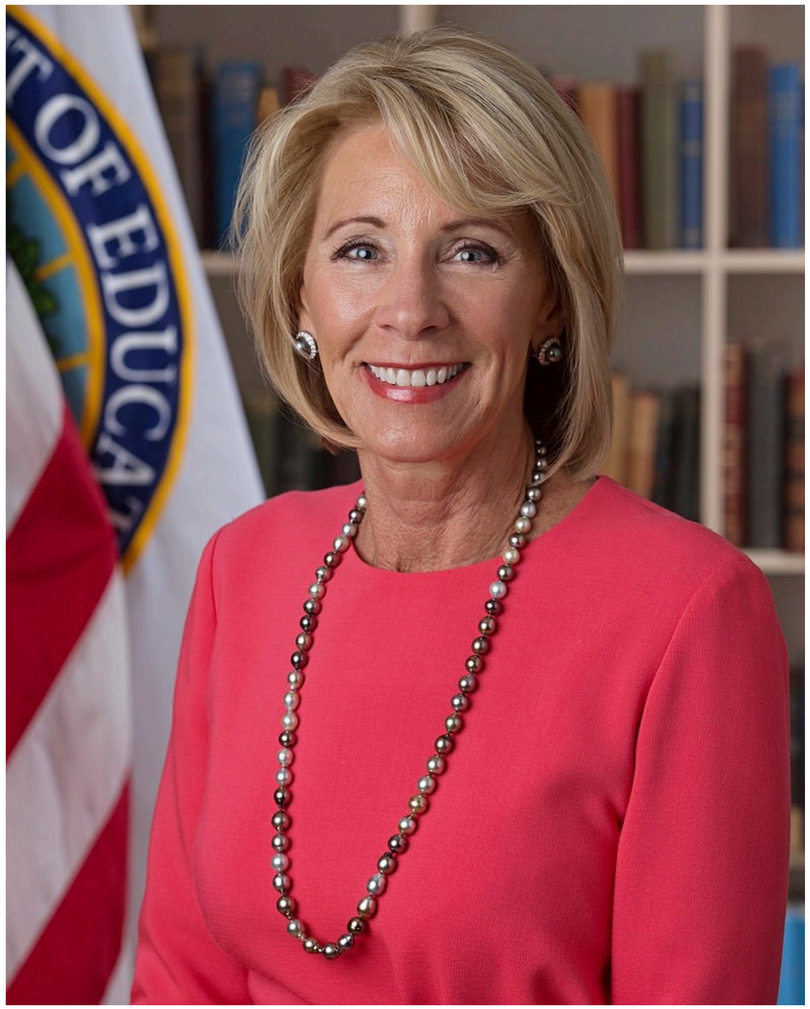
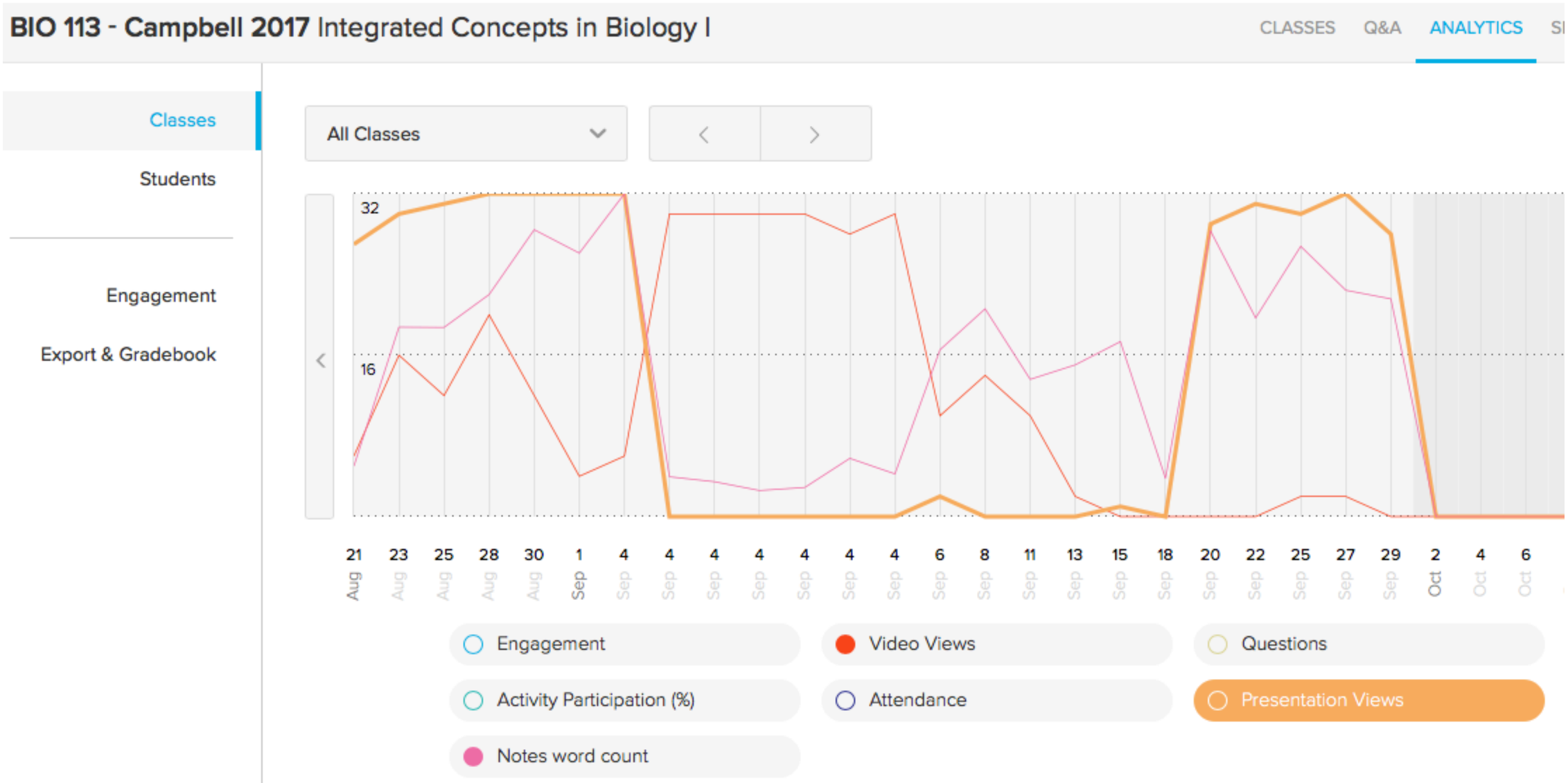


Example of Helpful Assessment

Echo360 records all classes (audio and slides)



Example of Helpful Assessment

All Classes

Search

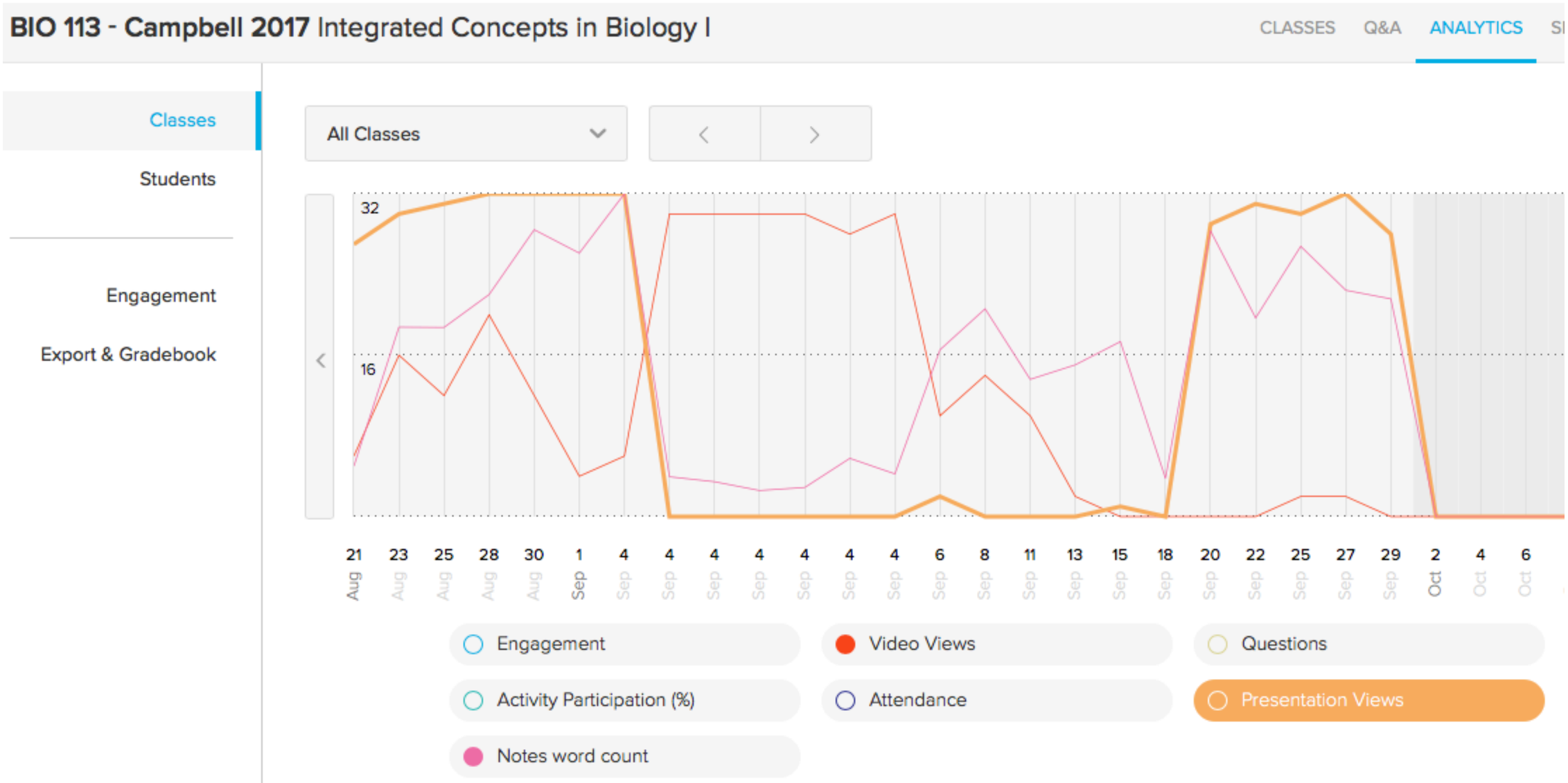
Echo360 Metrics

Name	Engagement	Attendance	Video views	Presentation views	Questions	Activity part. / correct	Notes word count
	14%	75%	10	13	0	96% / 70%	993
	10%	75%	0	12	0	96% / 75%	0
	9%	75%	0	9	0	96% / 80%	382
	10%	75%	0	12	0	96% / 80%	0
	10%	75%	9	12	0	96% / 90%	0
	16%	75%	7	12	0	96% / 65%	2715
	10%	71%	1	12	0	93% / 75%	0
	10%	75%	1	12	0	93% / 85%	0

Example of Helpful Assessment

I thought all students would use it equally – not true.

Who do you think uses it the most?



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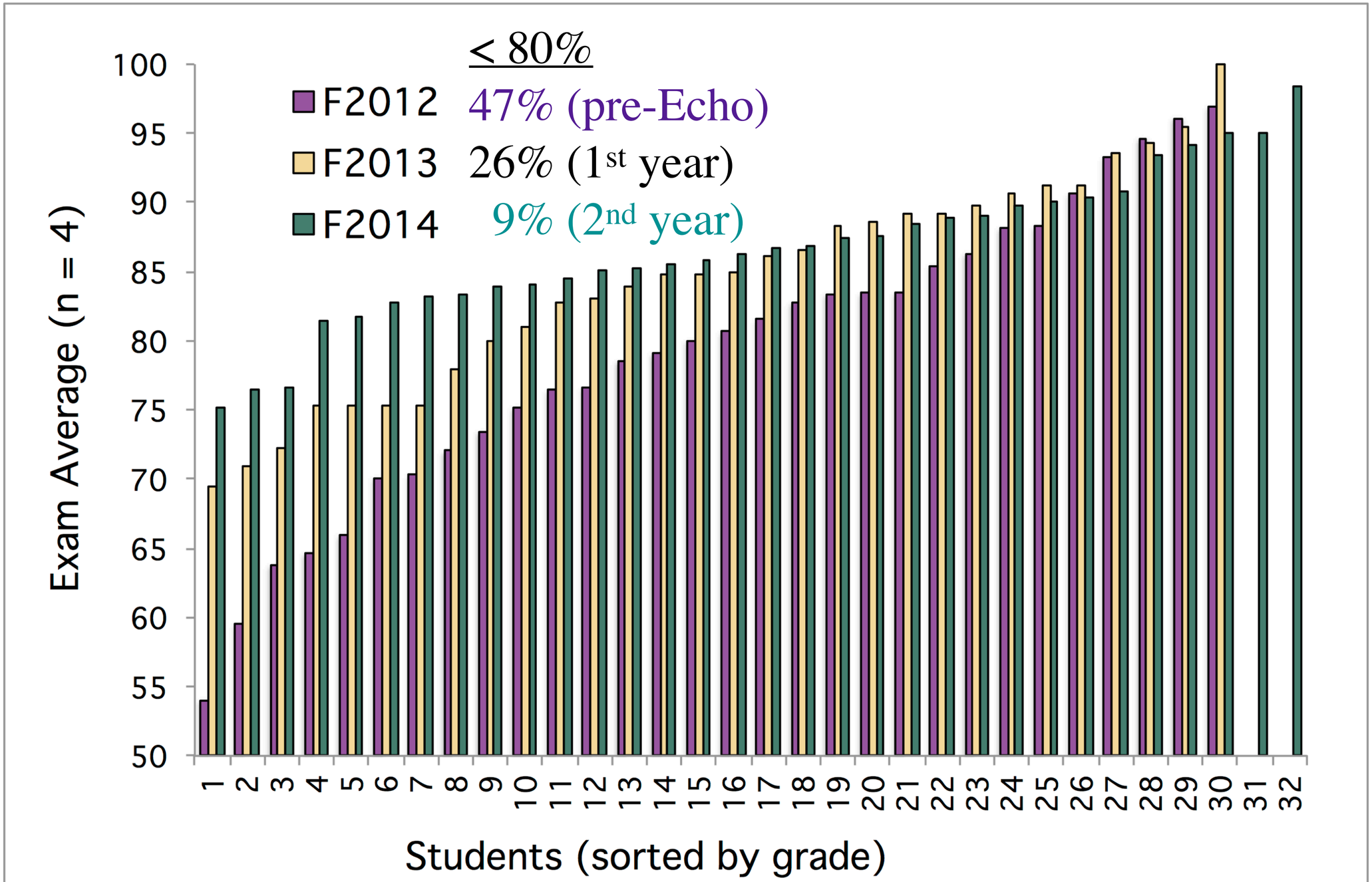
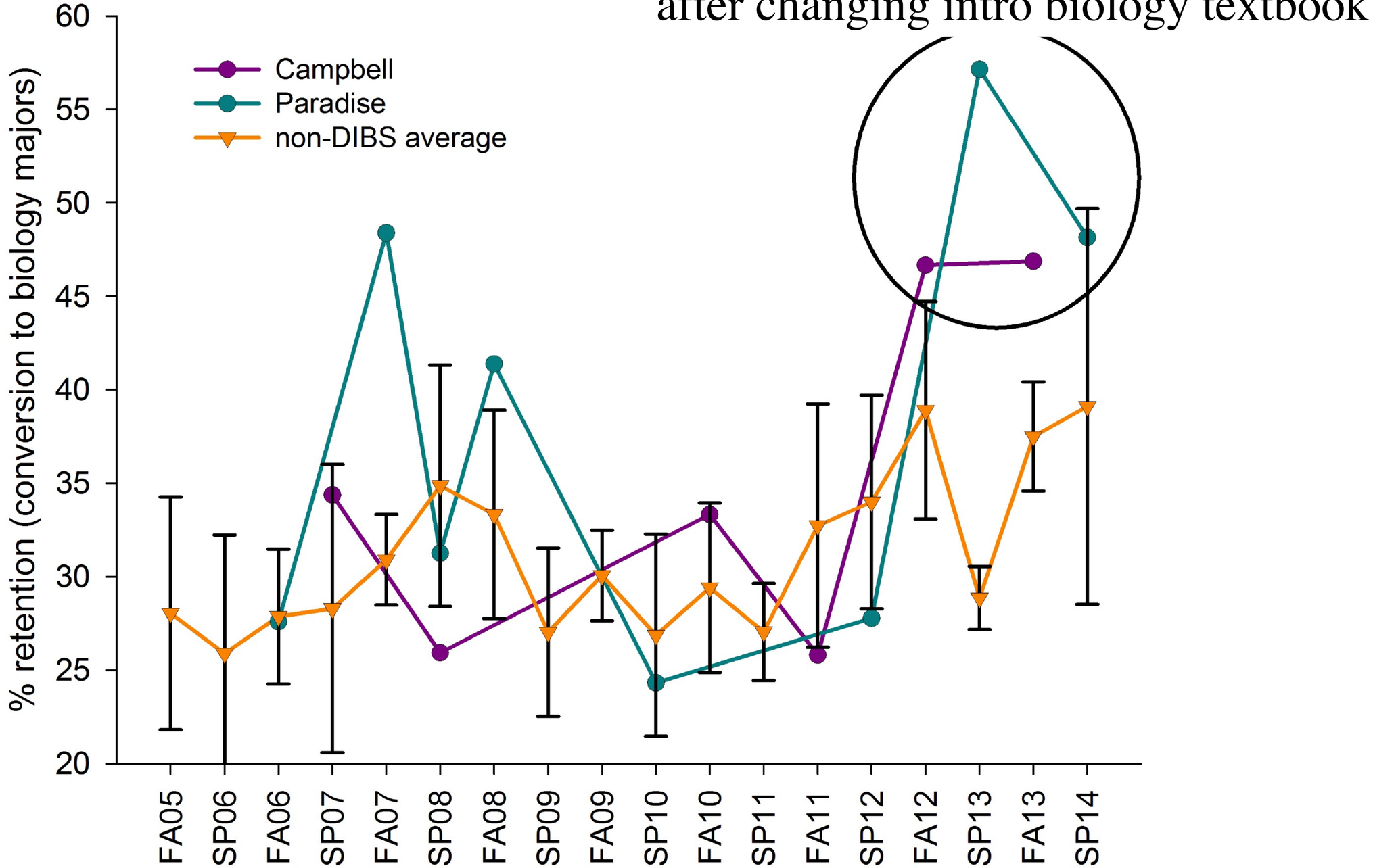
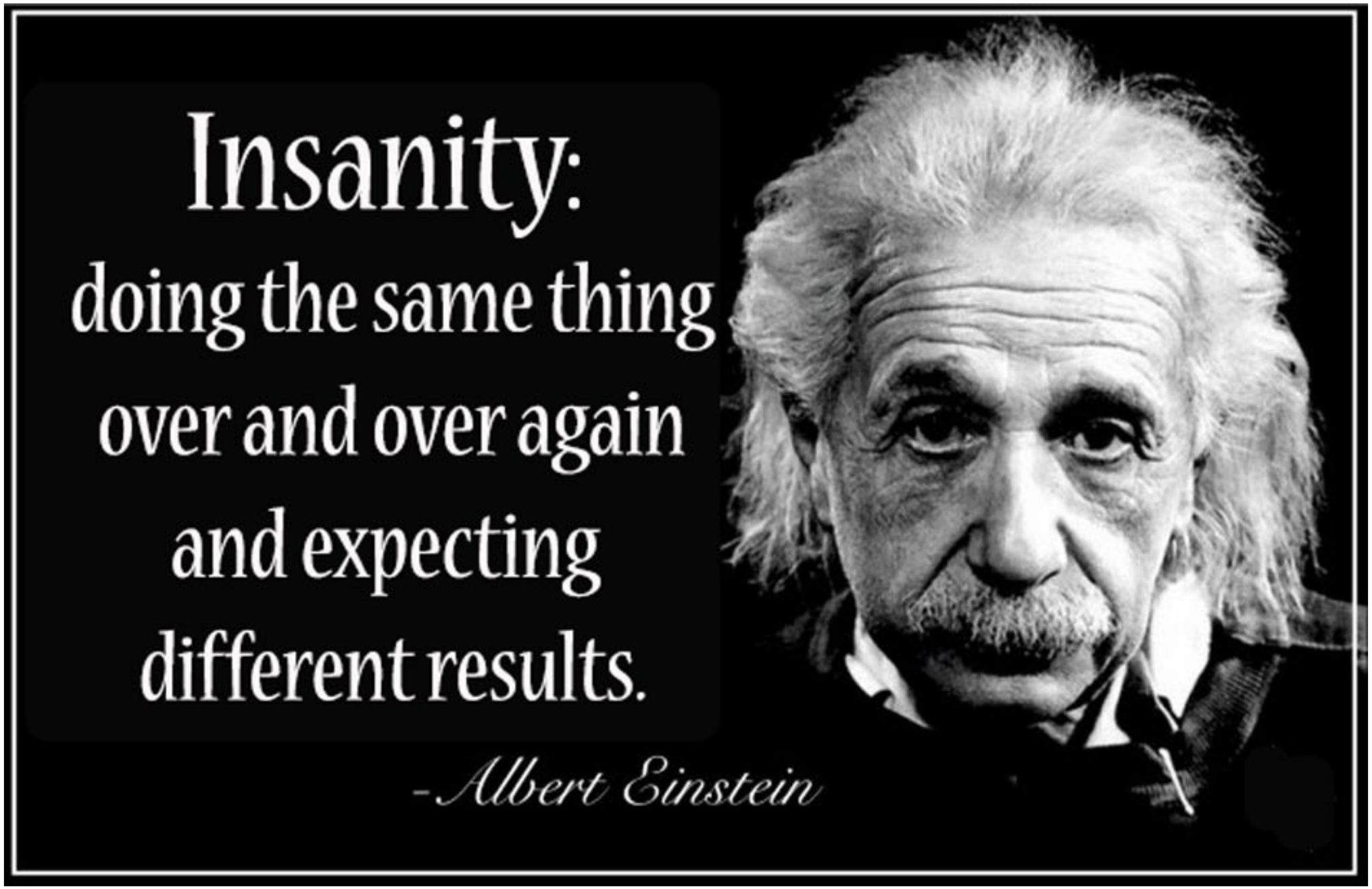


Example of Helpful Assessment

after changing intro biology textbook



Definition of Insanity



This year it will be different!

How many of you teach
upper level classes and
marvel at how little
students retain?

How many of you have
gotten course evaluations
that say class and lab are
not aligned?

http://www.personal.psu.edu/afr3/blogs/siowfa12/einstein-laughing.jpg

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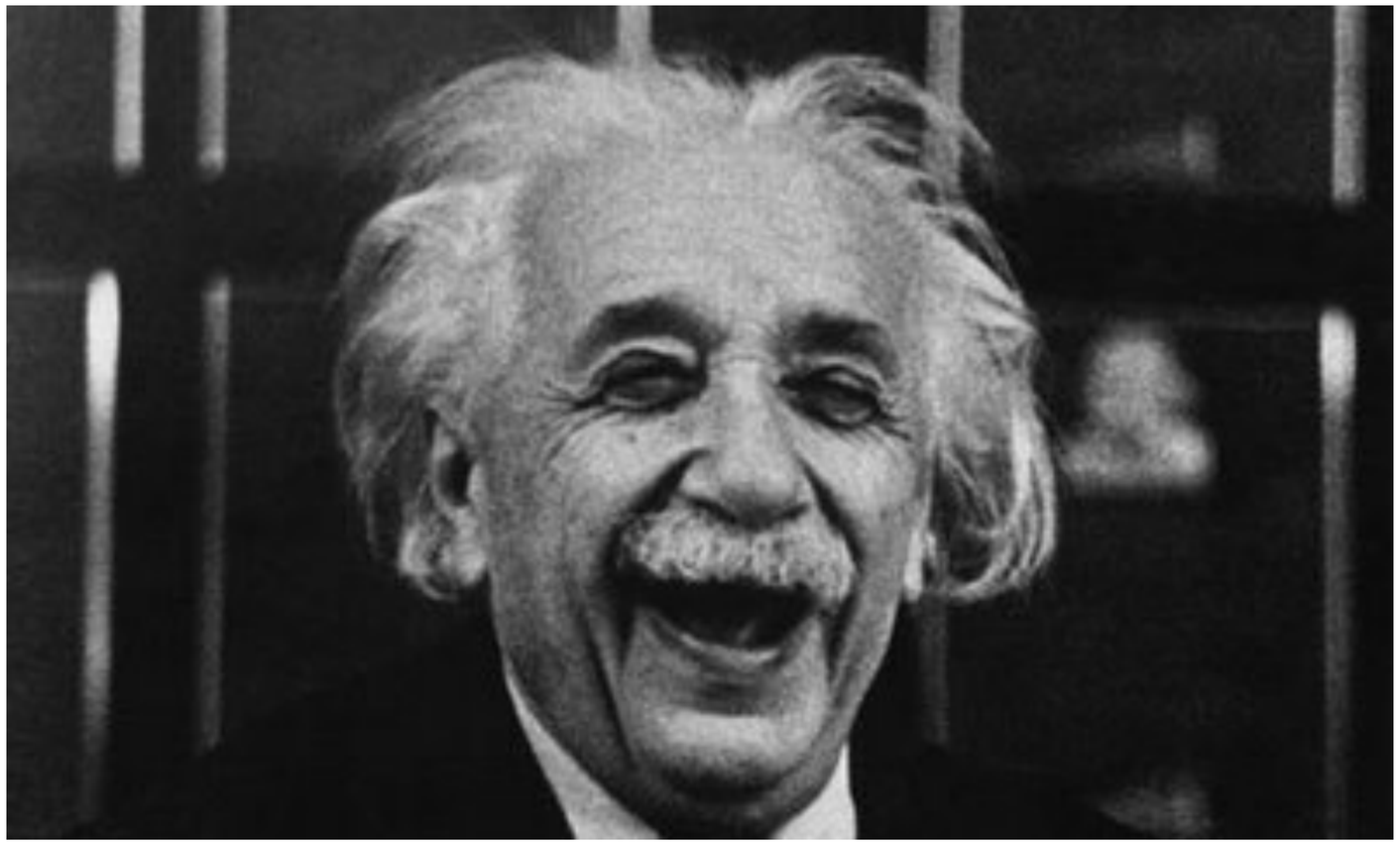

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Summation of Education Reform

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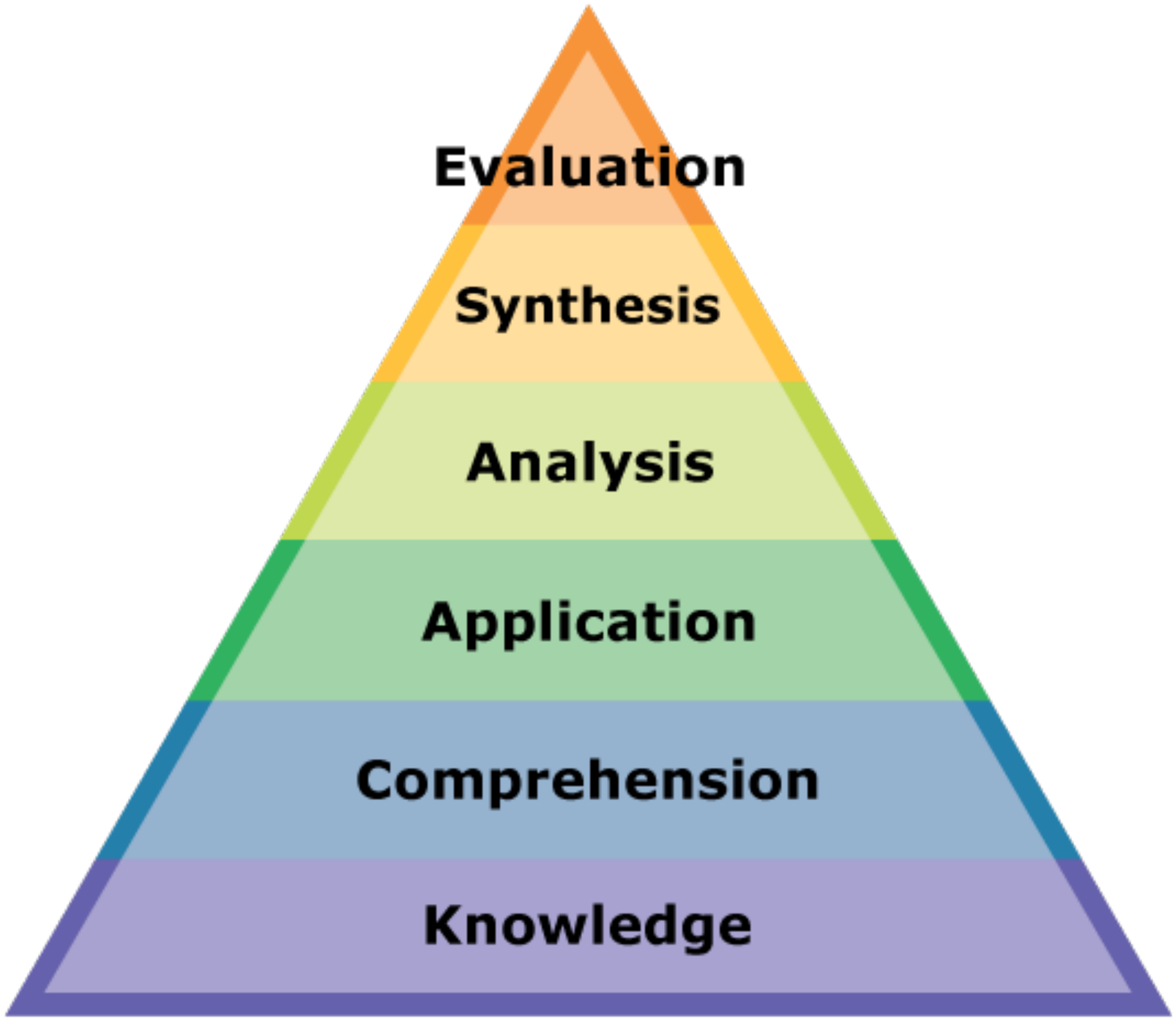
Backwards Design of Curriculum

1. What will your students be able to **do** after this lesson/activity/course? (learning objectives)

2. How will you know if they can do this?

3. How will your students gain this ability?

Bloom's Taxonomy of Learning



http://www.learnnc.org/lp/media/misc/2008/blooms_old.png

handout

Your Turn

Think of one class to focus on today.

Look at Bloom’s taxonomy & pick the level to target.

Write one learning objective using Bloom’s verbs.

Your Turn

Would you want your child/niece/ nephew to perform in a piano recital without practicing?

How is this analogous to assessing your students?

https://i.ytimg.com/vi/fKsQntn56fs/maxresdefault.jpg

Your Turn

https://cdn.theatlantic.com/assets/media/img/mt/2015/04/shutterstock_177793625-1//lead_large.jpg

If you want to change student behavior, you have to structure your class and your assessment to match your learning objectives.

Your Turn Examples

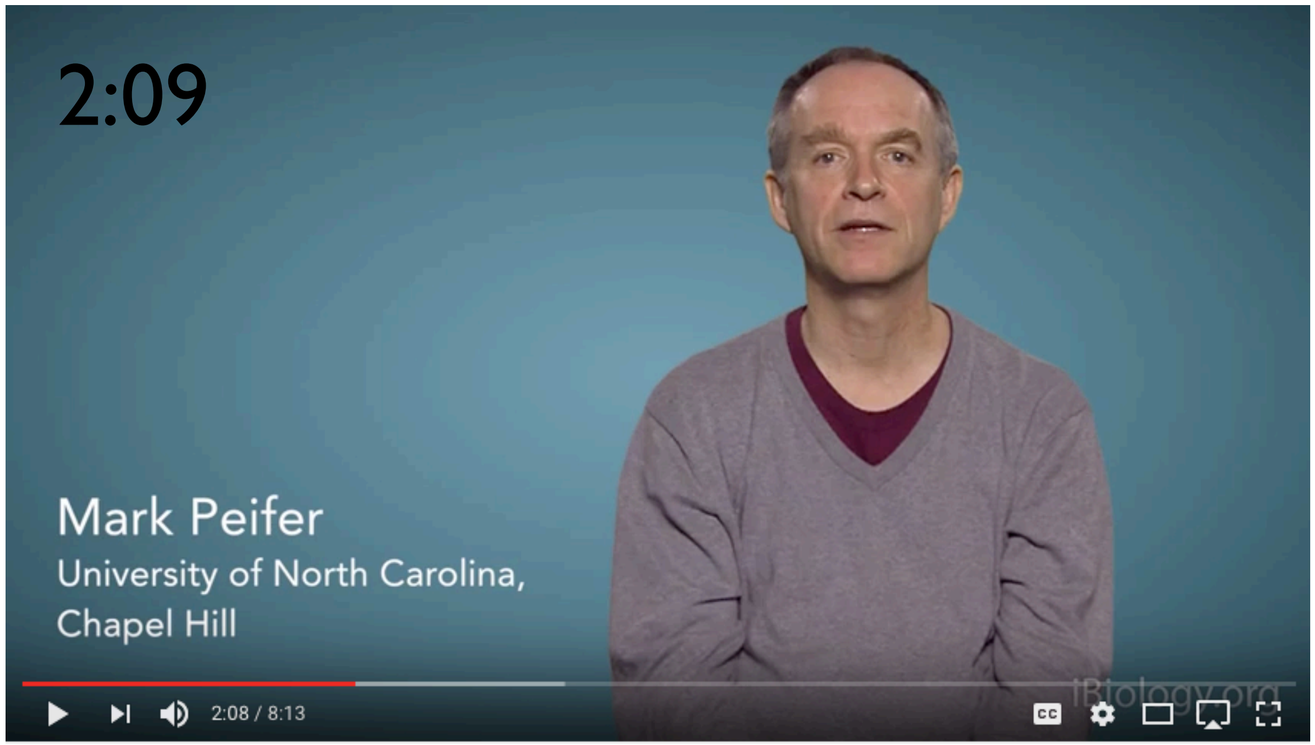
Do you want students to read before class?
Then don't tell them what they should have read.

If you don't expect them to read before class, why have a textbook in the first place?

Do you want students to see the big picture?
Then don't test them on minutia.

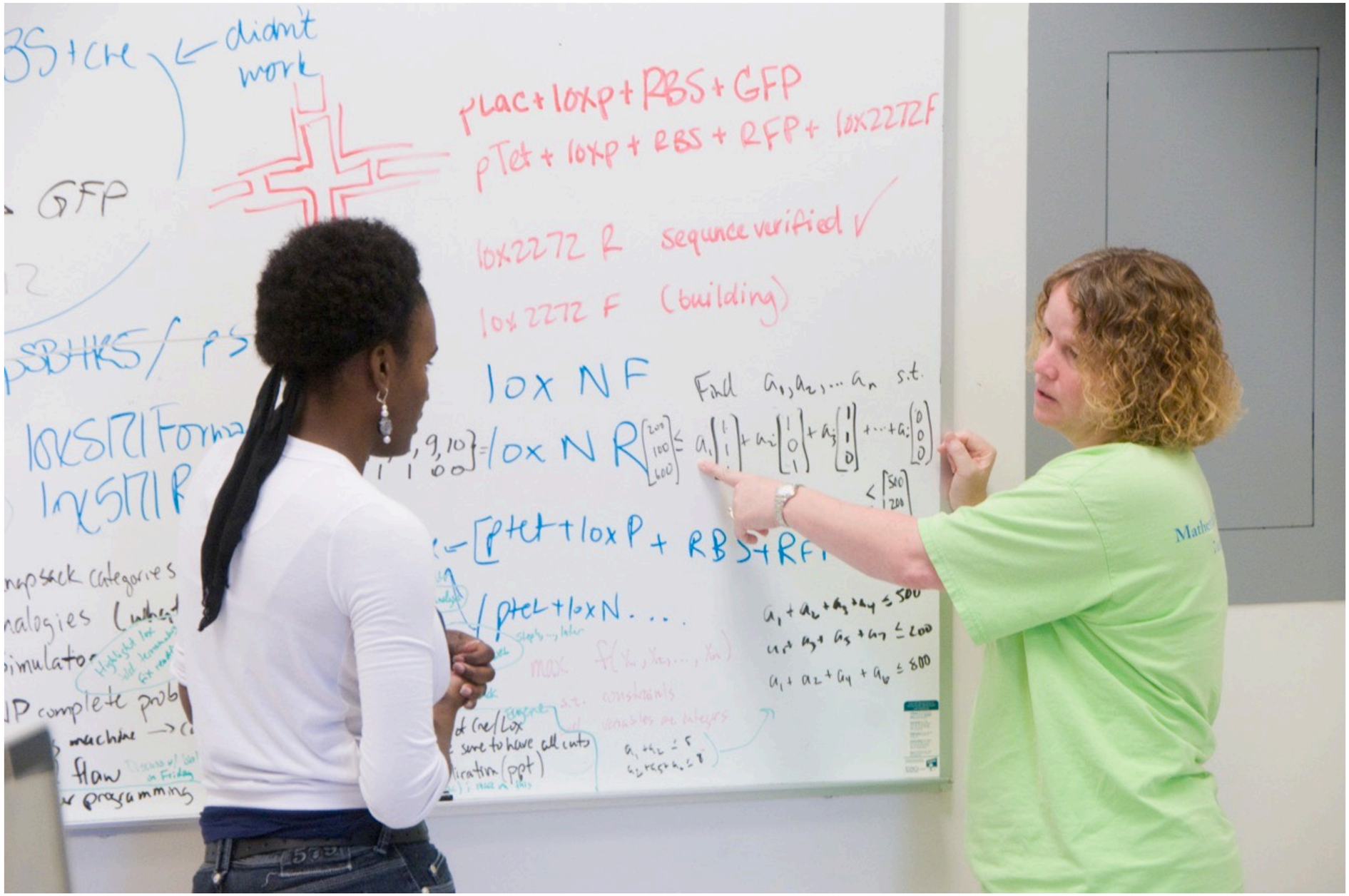
Do you want your student to interpret data?
Then give them real data for lots of practice.

“Students live up to our expectations, so don’t set them too low.”

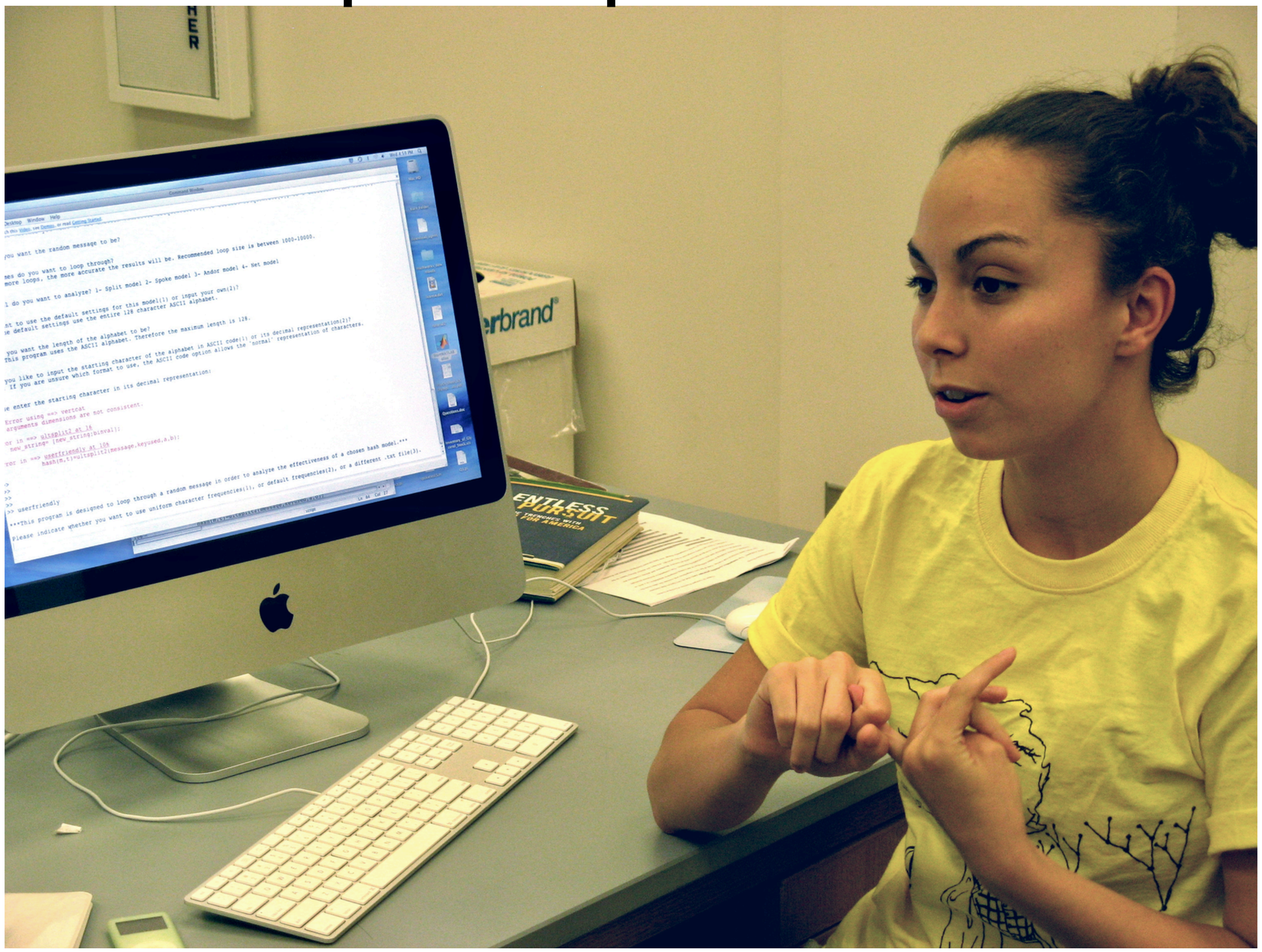


https://www.ibiology.org/scientific-teaching/active-learning.html

Goal: I want my students to think and act like scientists.



LO: Students will be able to analyze and interpret experimental data.



Types of Assessment

Formative assessment gauges how well students learned in short run. (quiz, clicker questions, think/pair/share, minute paper)

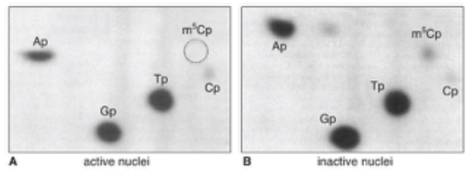
Summative assessment most common, final measurement to see what they retained. (exams, lab reports, term papers, etc).

No matter what type of assessment, connect them to learning objectives (what will students be able to *do*?)

Types of Assessment

Data Gallery

1



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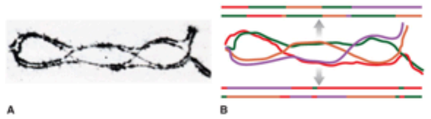
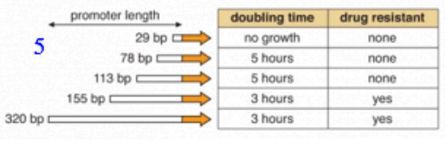


3

4

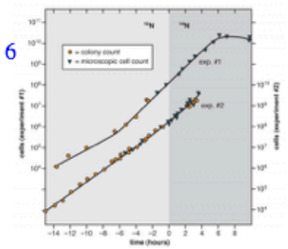
sample source	extracellular	intracellular
^{35}S-Protein Figure 1.8	~80%	~20%
^{32}P-DNA Figure 1.8	~30%	~70%
^{35}S-Protein refined experiment	~99%	~1%
^{32}P-DNA refined experiment	~30%	~70%

5



doubling time	drug resistant
no growth	none
5 hours	none
5 hours	none
3 hours	yes
3 hours	yes

6



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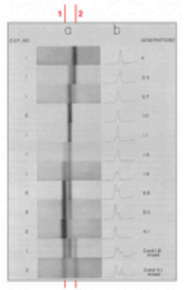

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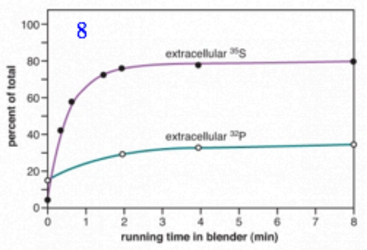

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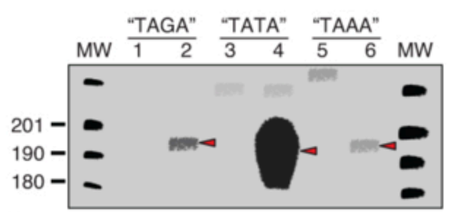
10

position #	1	2	3	4	5	6	7
A	–6.64	1.84	–6.64	0.84	1.26	–6.64	–0.72
C	–6.64	–6.64	–0.37	–6.64	–6.64	–6.64	–6.64
G	–0.37	–6.64	–6.64	1.18	–0.37	–6.64	1.92
T	1.57	–6.64	1.57	–6.64	–0.72	1.84	–6.64

11

plant number	smooth pea	wrinkled pea	plant number	yellow pea	green pea
1	45	12	1	25	11
2	27	8	2	32	7
3	24	7	3	14	5
4	19	10	4	70	27
5	32	11	5	24	13
6	26	6	6	20	6
7	88	24	7	32	13
8	22	10	8	44	9
9	28	6	9	50	14
10	25	7	10	44	18
totals	336	101	totals	355	123

12



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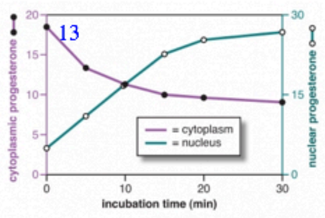

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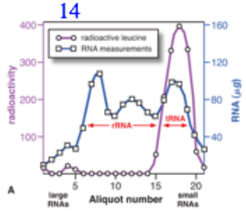

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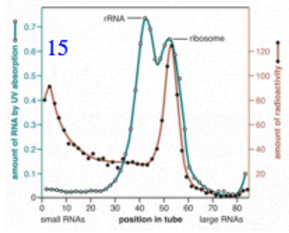

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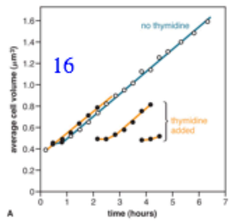

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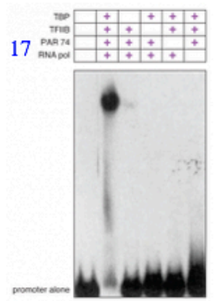


18

second base in codon

first base in codon	U	C	A	G
U	UUU phe F	UCU ser S	UAU tyr Y	UGU cys C
	UUC phe F	UCC ser S	UAC tyr Y	UGC cys C
	UUA leu L	UCA ser S	UAA stop	UGA stop
	UUG leu L	UCG ser S	UAG stop	UGG trp W
C	CUU leu L	CCU pro P	CAU his H	CGU arg R
	CUC leu L	CCC pro P	CAC his H	CGC arg R
	CUA leu L	CCA pro P	CAA gln Q	CGA arg R
	CUG leu L	CCG pro P	CAG gln Q	CGG arg R
A	AUU ile I	ACU thr T	AAU asn N	AGU ser S
	AUC ile I	ACC thr T	AAC asn N	AGC ser S
	AUA ile I	ACA thr T	AAA lys K	AGA arg R
	AUG met M	ACG thr T	AAG lys K	AGG arg R
G	GUU val V	GCU ala A	GAU asp D	GGU gly G
	GUC val V	GCC ala A	GAC asp D	GGC gly G
	GUA val V	GCA ala A	GAA glu E	GGA gly G
	GUG val V	GCG ala A	GAG glu E	GGG gly G

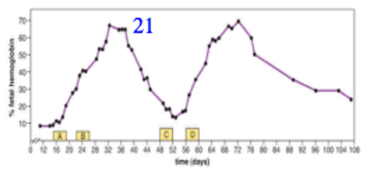
19

genotype	– lactose	+ lactose
I^+ O^+ β^+ P^+	1	100
I^- O^+ β^+ P^+	100	100
I^s O^+ β^+ P^+ / I^s O^+ β^+ P^+	1	240
I^s O^+ β^+ P^+	1	1
I^s O^+ β^+ P^+ / I^s O^+ β^+ P^+	1	2
I^s O^- β^+ P^+	<1	<1
I^s O^- β^+ P^+ / I^s O^+ β^+ P^+	1	100

20

```
V-T7      5'...TAAACACGGTACGATGTACCACATGAAACGACAGTGAGTC... 3'
V-1d      5'...GCTTCTGACTATAATAGACAGGGTAAAGACCTGATTTTTG... 3'
V-SV40    5'...ATTGCAGCTTATAATGGTTACAAATAAAGCAATAGCA..... 3'
V-1       5'...ACTGGCGGTGATACTGAGCACATCAGCAGGACGCACTGAC... 3'
B-tRNA    5'...GTCATTTGATATGATGCGCCCCGCTTCCCGATAAGGAGC  ... 3'
B-Lac     5'...TCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAA... 3'
```

21



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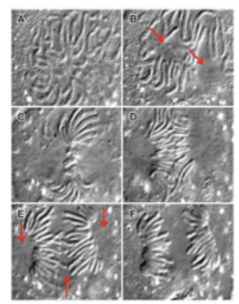

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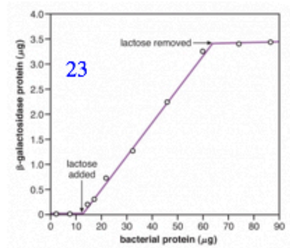

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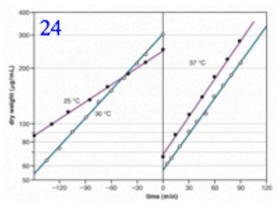

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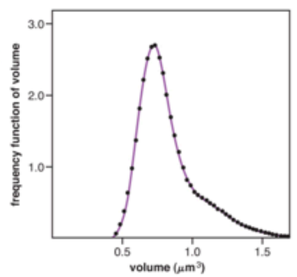
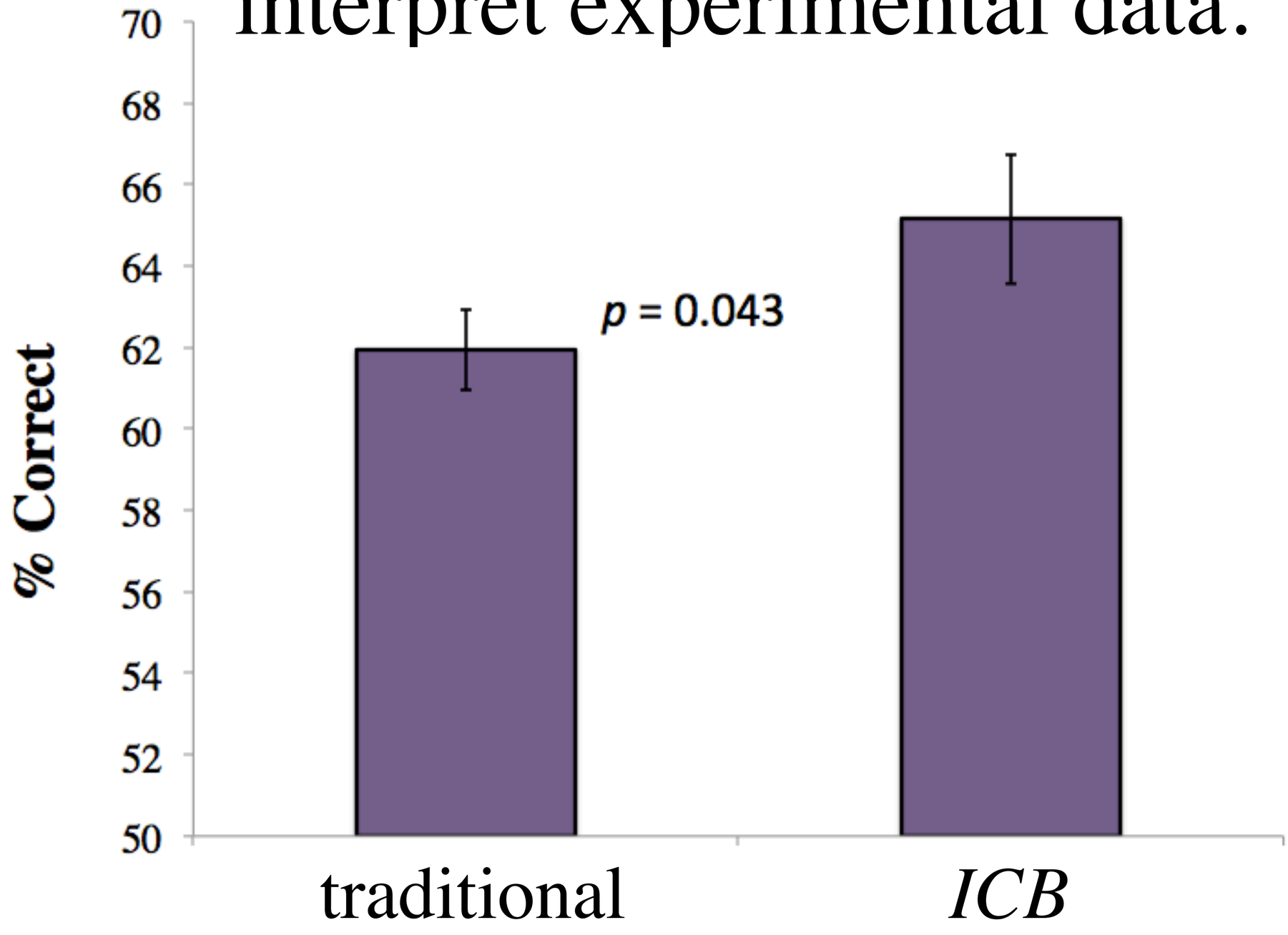


LO: Students will be able to analyze and interpret experimental data.



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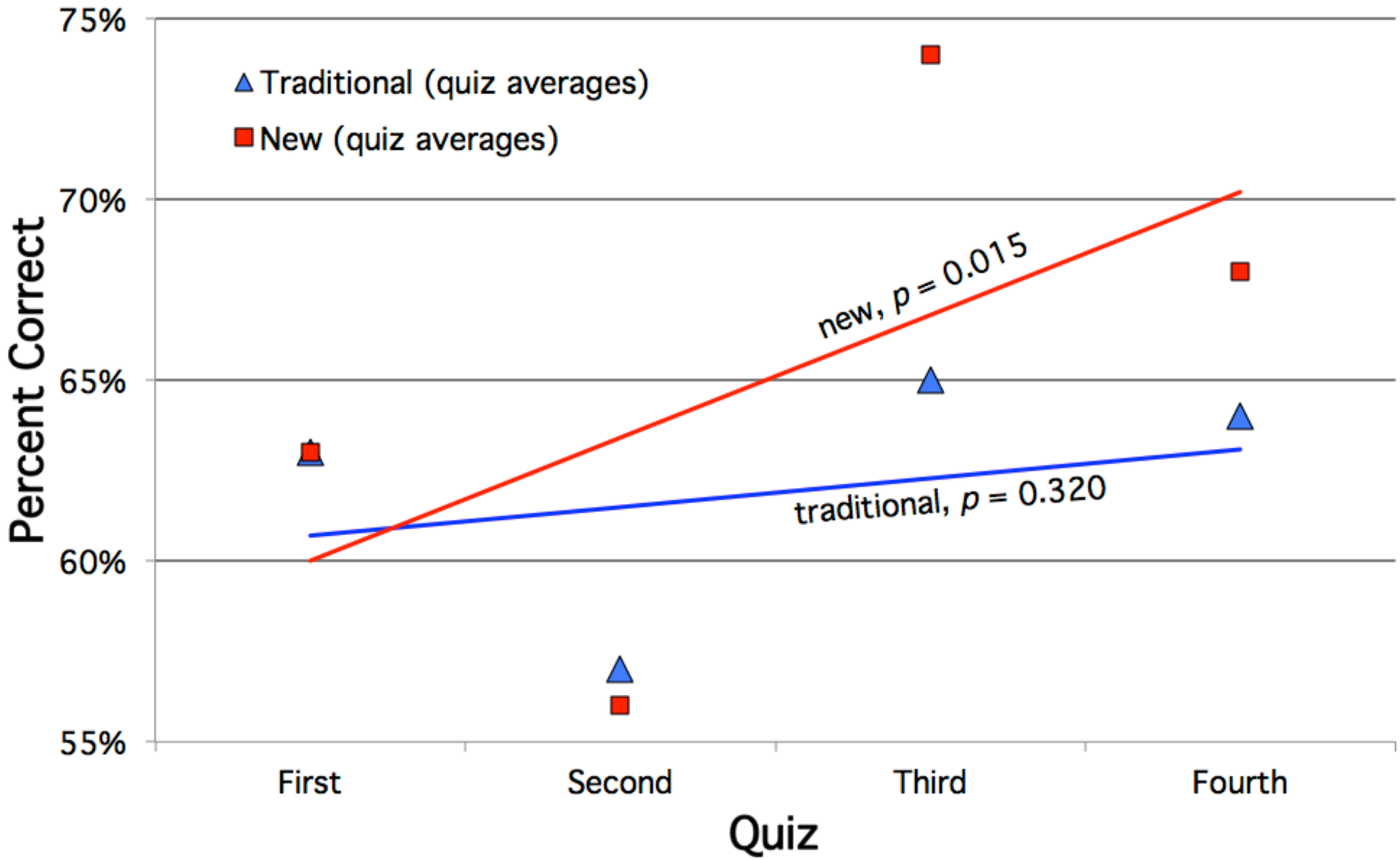
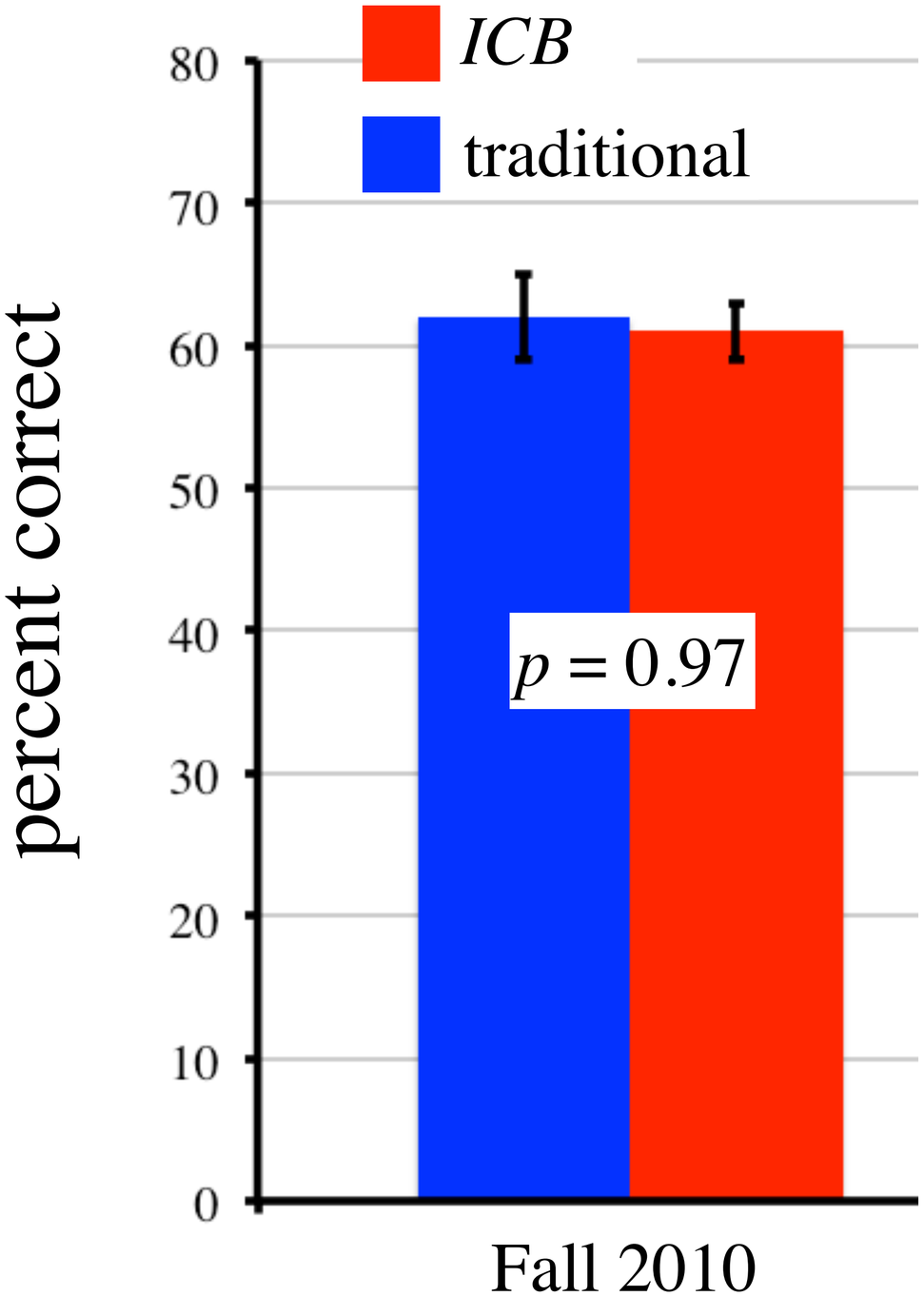


Criticisms Became My Learning Objective

http://www.olivetuniversity.edu/images_articles/files//faculty_meeting_1.jpg

“Your students won’t learn core concepts.”



+/- SEM

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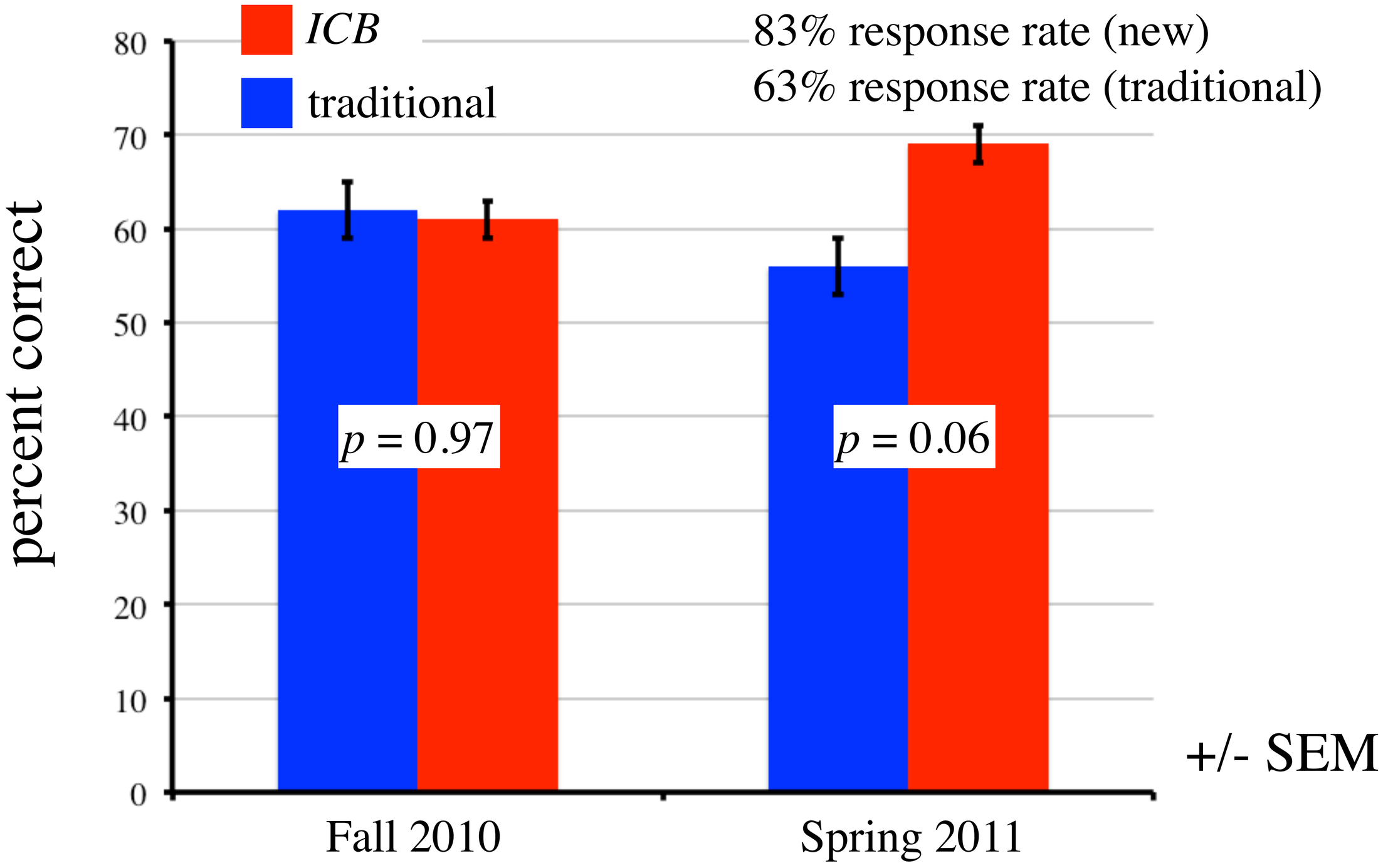

Your Turn

Formative

- Minute papers
  - What is major lesson today?
  - What is still confusing to you?
- Skim these to see what worked and what did not.
- Spend more class time, give as homework, or move on??
- What are your learning objectives?
- Do you have too many learning objectives?
- Definition of insanity…

Your Turn

Summative

- Draw experimental design for a critical experiment
  - cannot BS a drawing
  - I learned that students have no sense of size scale when I asked them to draw a picture of IDH
- Assemble evidence that supports our understanding of…
- Interpret data taken from relevant literature.

Your Turn

Generate one assessment piece that could measure whether your students accomplished the LO.

Teaching Should Be Fun!