Creating Effective Learning Environments: Five Easy Steps to Peer Instruction

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Physics
STEM Education Initiatives

MSU College Teaching Certificate
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Props to:
Stephanie Chasteen, CU Boulder and SEI
Eric Mazur, Harvard University
Derek Bruff, Vanderbilt
Kathryn Spilios, Boston University
Andrew Duffy, Boston University
Jenny Knight, CU Boulder
Rique Campa, MSU
Peter Newbury, UCSD

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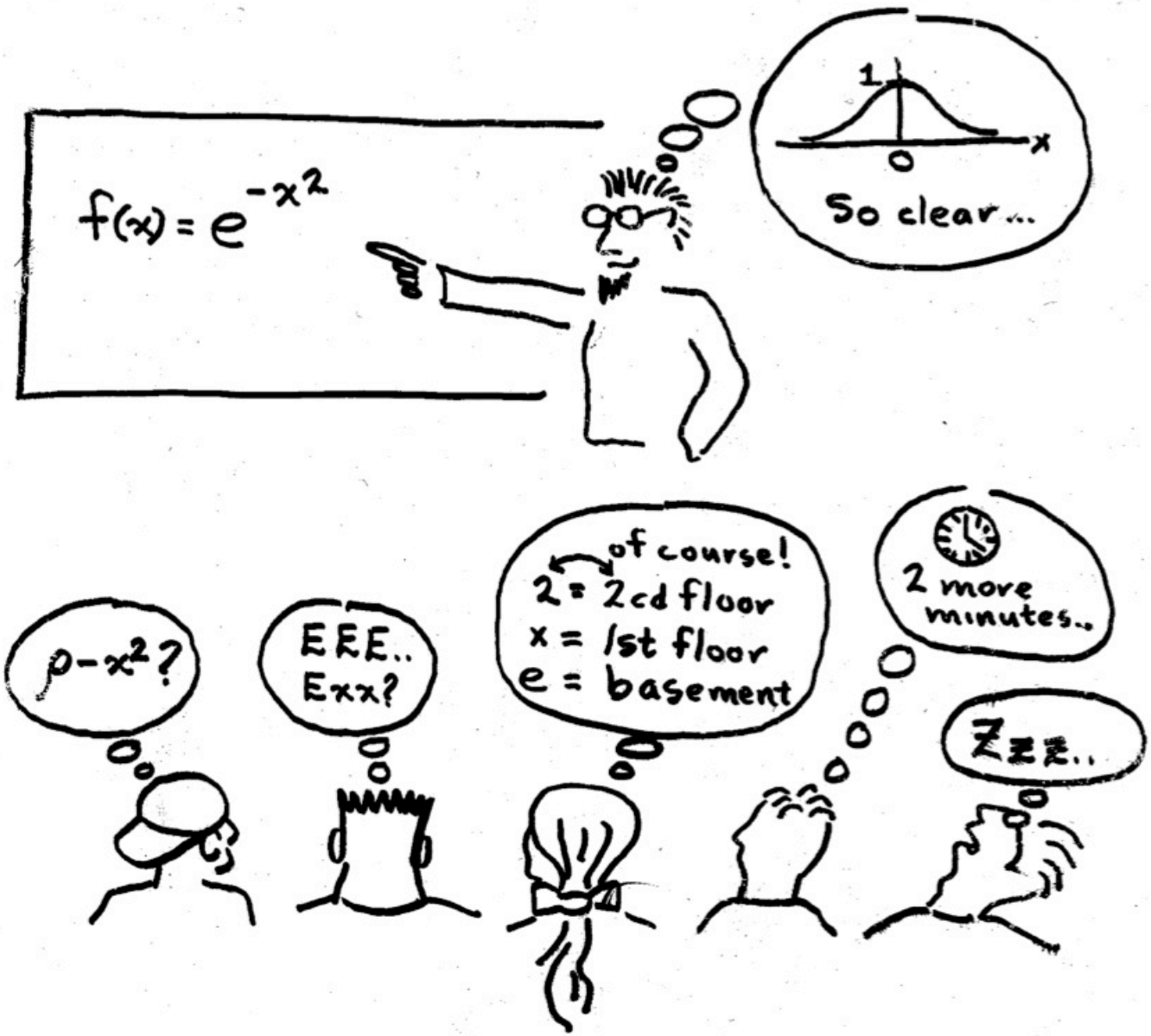
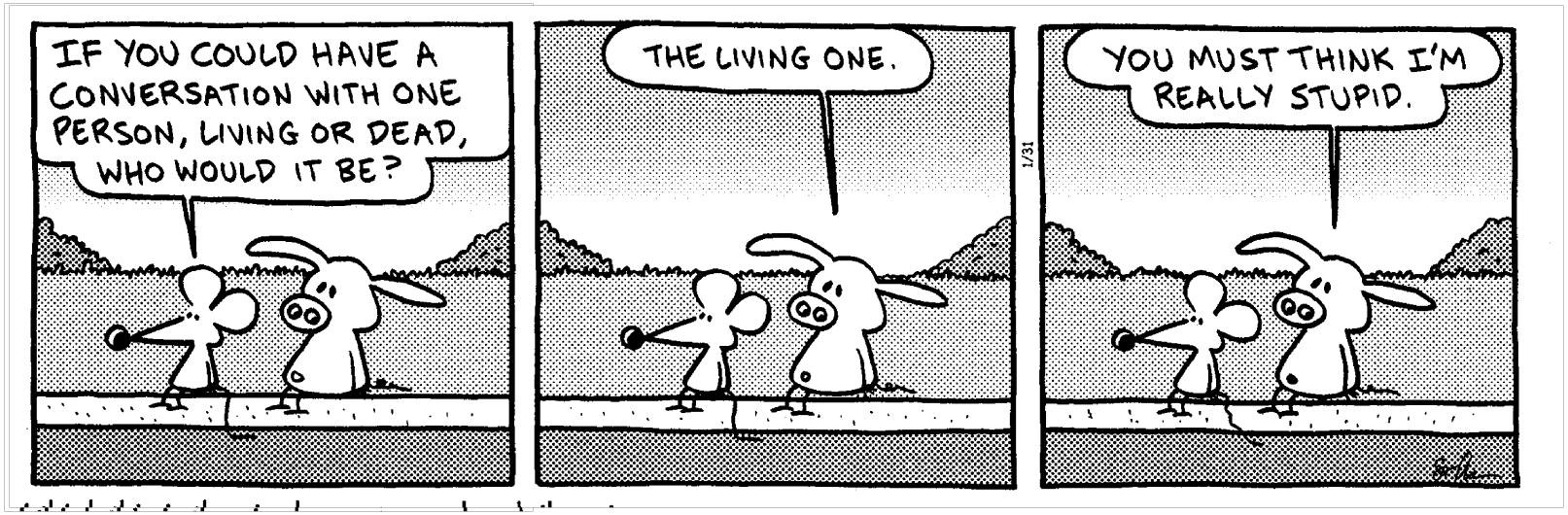

$f(x) = e^{-x^2}$
1
x
0
So clear...
$\rho - x^2$?
EEE..
Exx?
of course!
2 = 2cd floor
x = 1st floor
e = basement
2 more minutes..
Zzzz..

Two way conversations with students are vital...



...because students can misunderstand what we say

"Pearls Before Swine" by Stephan Pastis, 2002.

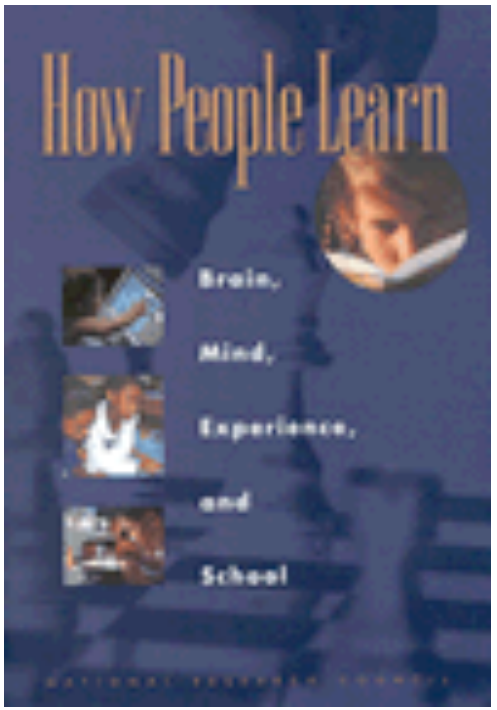
"Clickers" are really just a focal point

We aim to help instructors:

- Use student-centered, interactive teaching techniques
- By the use of a tool (clickers) which makes a transition to that pedagogy easier

Our talks are "how people learn"

talks in disguise. ☺



Bransford, Brown, Cocking (1999), *How People Learn*

Using the "Clicker"

The clickers should be easy to use. When I ask a multiple-choice question and start the timer, just choose an answer and hit that button on your clicker.

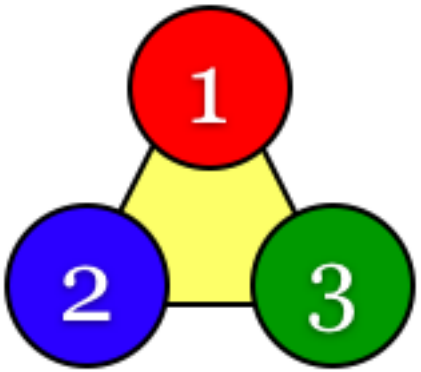
Clicker responses (right or wrong) count toward your participation grade.

Why we're using clickers

The clickers are designed to get you involved in the class, by encouraging discussion between you and your classmates and between you and the course staff.

Icons for peer instruction

This icon means this is an individual activity - start by answering the questions on your own.



When you have done this individually, compare notes with the members of your group.

Have you used response systems (clickers) in your teaching?

- Take a clicker
- If the green light flashes, your vote has been counted

1. Not at all, and I haven't seen them used
2. Not at all, but I've observed their use somewhat
3. I've used them a little
4. I've used them a lot
5. I could be (should be?) *giving* this workshop

How familiar are you with “Peer Instruction”

1. Fairly familiar, and I like it
2. Fairly familiar, but I’m not sure that I like it
3. I’ve heard of it but only have a vague idea what it is
4. Not familiar at all
5. Not sure

Example question: Biology

A small acorn over time can grow into a huge oak tree. The tree can weigh many tons. Where does most of the mass come from as the tree grows?

1. Minerals in the soil
2. Organic matter in the soil
3. Gases in the air
4. Sunlight

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Minimum length

When you add two vectors, with lengths of 4.0 m and 7.0 m, what is the minimum possible length of the resultant vector?

1. -3.0 m
2. 0 m
3. +3.0 m
4. +4.0 m

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Just subtract the two. Length is a scalar, and can't be negative.

Clicker question about questions

The toughest thing about asking questions in class is…

1. Writing good questions
2. Getting students to really think about them
3. Getting students to answer the questions / Nobody responds
4. The same students always respond / Not everybody responds
5. It takes too long / I have a lot of content to cover

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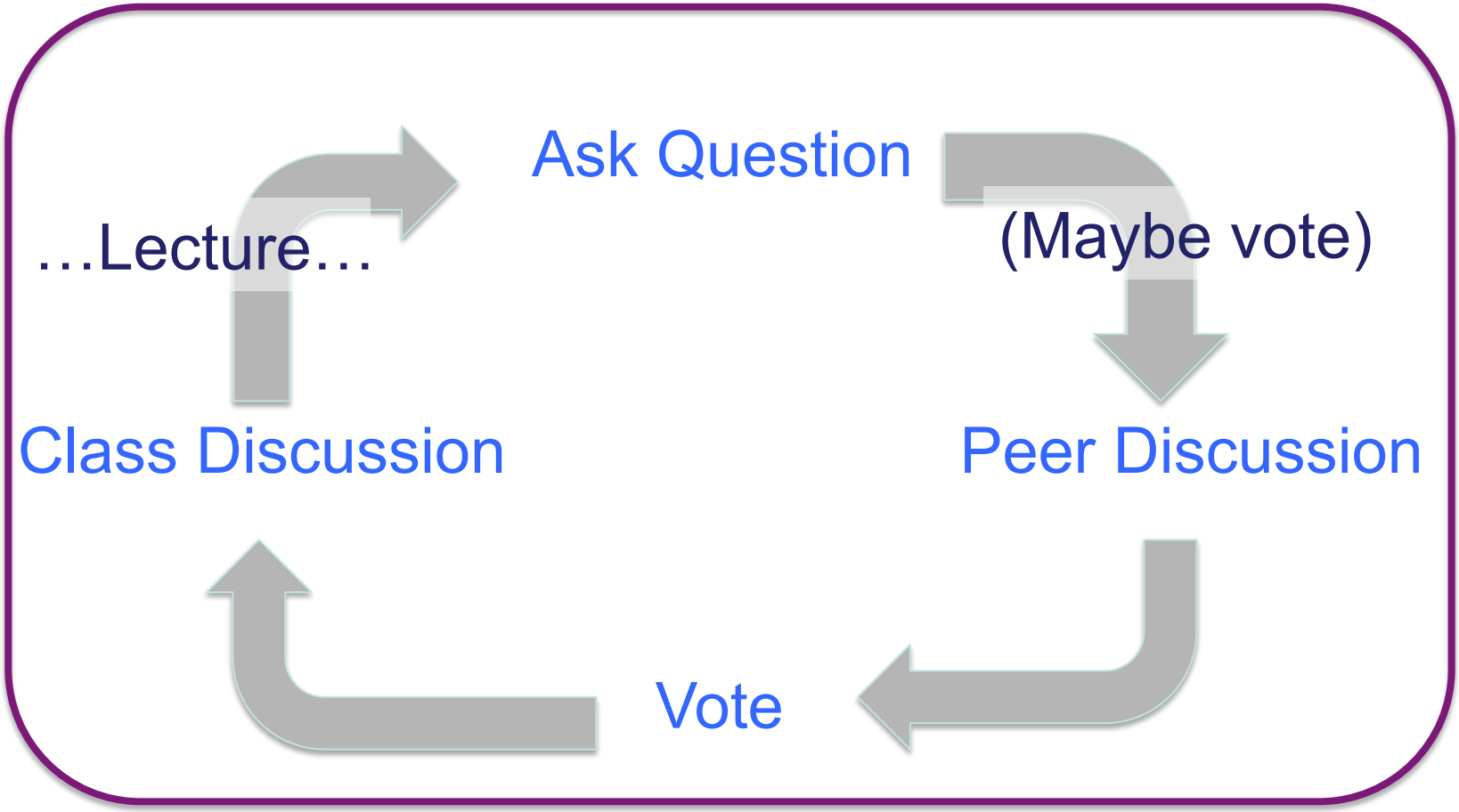
Presentation and Observation of Peer Instruction

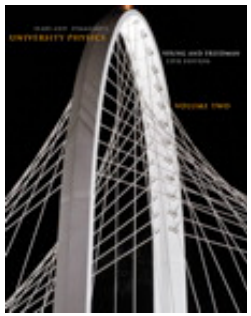
Part B: Elements of Peer Instruction

Anatomy of Peer Instruction



* See also: Peer Instruction, A User's Manual. E. Mazur.

Doing Physics: Active-Learning

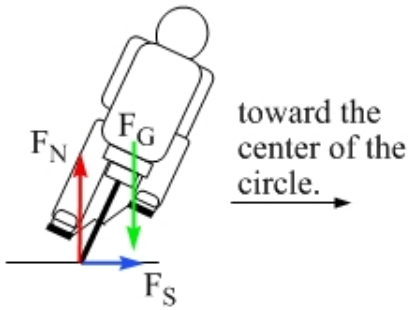


Active-Learning
Class

Small-Group
Discussion

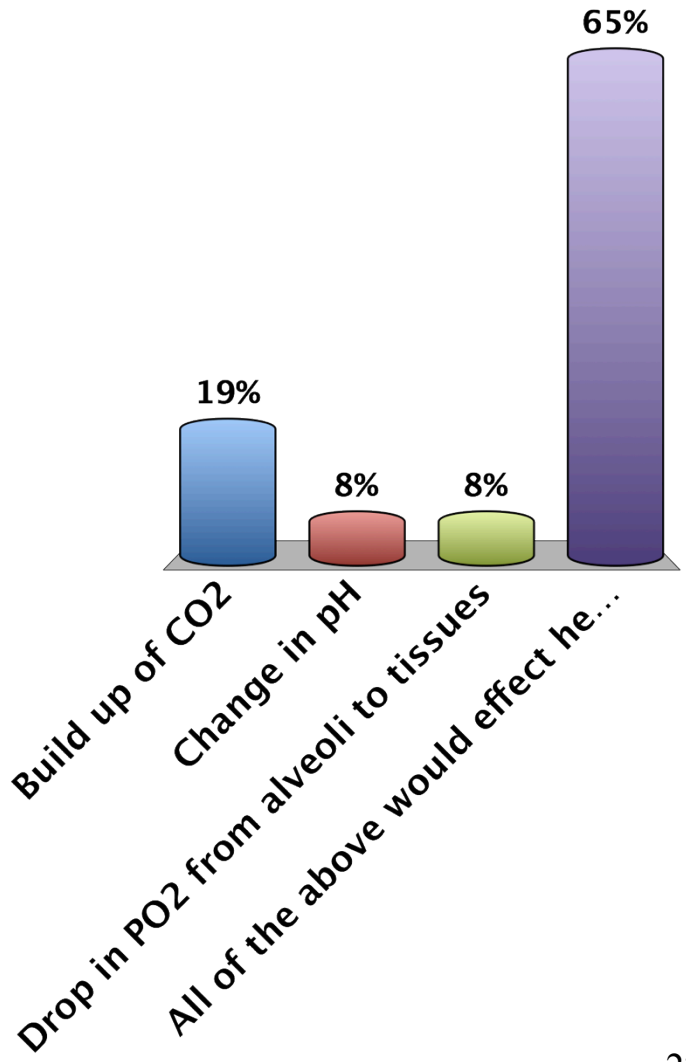
Homework/Quiz
Practice

Pre-Class
Preparation



The following is a list of changes in a tissue undergoing cellular respiration. Which of them would have NO EFFECT on hemoglobin's affinity for oxygen?

A. Build up of CO_2
B. Change in pH
C. Drop in P_{O2} from alveoli to tissues
✓ D. All of the above would effect hemoglobin's affinity for O_2



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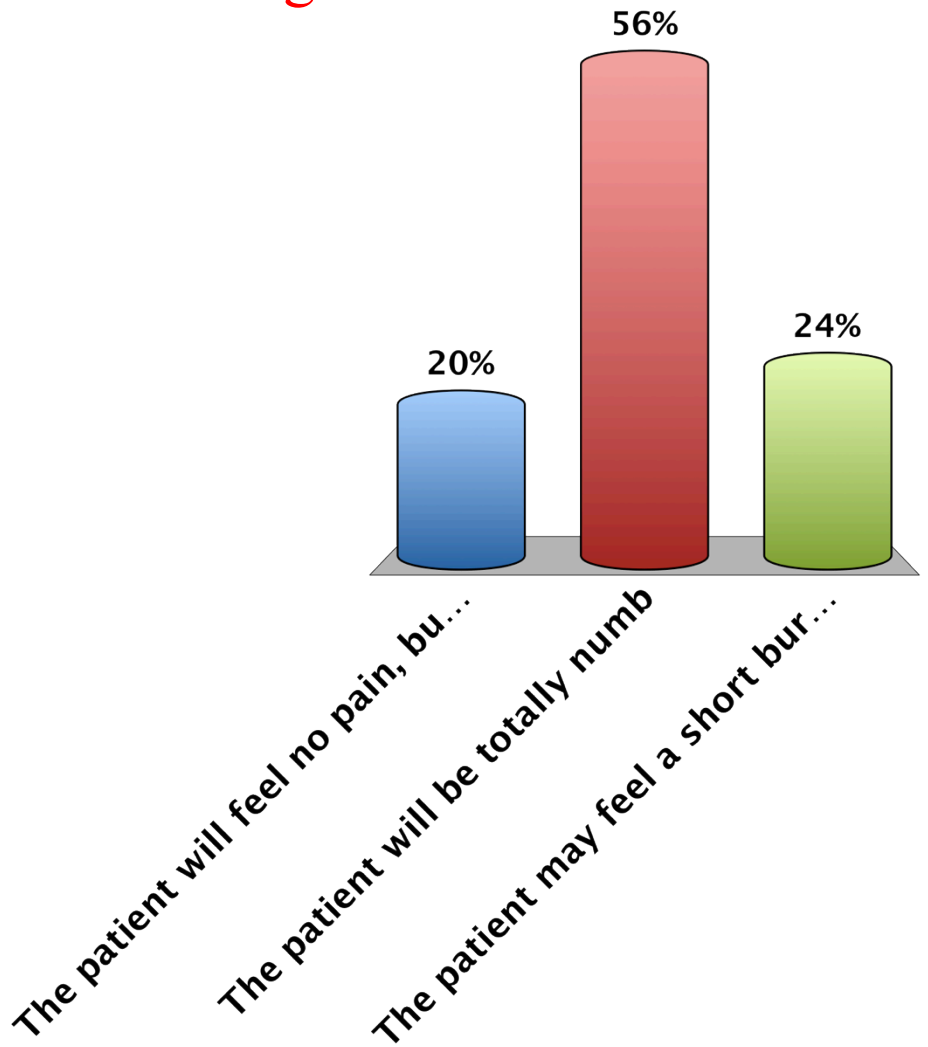
You have discovered a molecule that blocks K+ channels in sensory neurons in the skin. You'd like to market this drug as a pain management drug. Which of the following would be the most accurate description of the drug's effect?

A. The patient will feel no pain, but will still feel touch and pressure

B. The patient will be totally numb

✓C. The patient may feel a short burst of pain and sensation, followed by numbness



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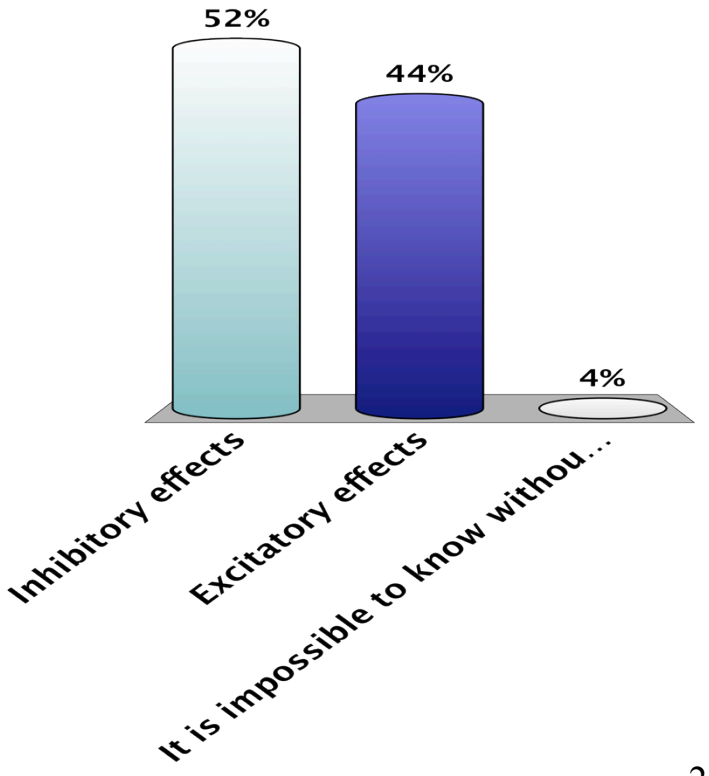
You are studying a neuron that you isolated from an animals. When you examine the synaptic vesicles you discover that they contain an unknown neurotransmitter. The neurotransmitter seems to open K+ channels on other neurons. You hypothesize that your neuron has

✓A. Inhibitory effects

B. Excitatory effects

C. It is impossible to know without more info



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Analyze Step 1: Question Cycle: Before/During/After

BEFORE
Setting up instruction

Motivate
Discover
Predict outcome
Provoke thinking
Assess prior knowledge

DURING
Developing knowledge

Check knowledge
Application
Analysis
Evaluation
Synthesis
Exercise skill
Elicit misconception

AFTER
Assessing learning

Relate to big picture
Demonstrate success
Review or recap
Exit poll

Credit: Rosie Piller and Ian Beatty.

When to ask questions 1: Before & After

Before Instruction

- **Motivate** students
  - Why is it important to…?
  - What might we want to…?
  - What kinds of things can go wrong?
- Help them **discover** information
  - What do we have to take into account when we…?
  - What needs to happen when you…?
  - Predict and show: We have seen that X happens when we do Y. What do you think will happen when…?
- Assess **prior knowledge** or **provoke** thinking/discussion
  - What do you think about…?
  - Would you/do you…?
  - What do you think will happen if…?

After Instruction

- Have students **recap** what they have learned
  - What steps did you go through to solve the problem?
  - What are the most important things to remember?
  - Exit poll: What did we learn today?
- Ask them to relate information to the **big picture**
  - How does this lead into the next topic?
- Demonstrate **success** and **limits** of understanding
  - *Ask questions that students have built an understanding of during the class.*
  - *Ask questions that go beyond what was done in class*

See also the Bloom's Taxonomy handout for question stems

When to ask questions 2: During

- Test **knowledge** of facts
  - What are the three types of…?
  - Can you define…?
- Test **comprehension** of concepts
  - Which statements support…?
  - What examples can you think of?
- Test **applications** of concepts
  - What would happen if…?
  - Which of the following are X?
- Help them **analyze** what they are learning
  - Based on the symptoms, what would you say is going on?
  - What is the relationship between…?
- Test their ability to **evaluate**
  - Here are two solutions. Which is more appropriate and why?
  - Which of these is more important?
- Provoke them to **synthesize** their understanding.
  - How would you test…?
  - Propose a way to…
- Elicit a **misconception**
  - *Ask questions where a common student misconception will result in a particular response*
- Exercise a **skill**
  - How would you…?
  - What is the next step in this problem?

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See also the Bloom's Taxonomy handout for question stems

Analyze Step 2: Use questions at a variety of cognitive depth

Bloom's Taxonomy of the Cognitive Domain

Do the questions you use intellectually challenge your students or simply assess their factual knowledge?

Higher order

Lower order

handout

Analyze Step 3: Effective multiple-choice questions have *believable* "distracters."

1) Talking with other instructors that have taught the course in the past.
2) Talking with your students one-on-one before class, after class, during office hours.
3) Using student responses to open-ended questions that you include in HW and exams.
4) Asking your students to come up with answers that will be used as the choices.
5) Use researched and documented student misconceptions.

Part C: Let's analyze clicker questions

For each of the three clicker questions, together analyze the questions on the first page of Part C.

Once you are done, start on the second set of clicker questions, revised version of the first set

Question-writing tips

- Move away from simple quizzes
- Use questions that prompt discussion
- Use questions that emphasize reasoning or process
- Use clear wording
- Use tempting distracters
- Use questions for a variety of instructional goals
- Use questions at a mixture of cognitive depth
- Ask challenging questions – don't just test memorized facts

See handout

Tips for writing clicker questions*

*particularly for use with peer instruction

- **Don't make them too easy.** You can ask multiple choice questions at higher levels of Bloom's! Don't just test memorized facts.
- Use questions that will **prompt discussion.** Interesting questions that students can't answer on their own are more likely to spur productive discussion.
- Use questions that emphasize **reasoning or process** over the right answer. Students need to be convinced that understanding strategies will get them a good grade.
- Use **clear wording** so that students understand what they are being asked.
- Write **tempting distractors** using your knowledge of student difficulties. For example, look at student answers on exams or quizzes, or first give the question as an open-ended question to generate common wrong answers.
- **Consider creative questions.** You can survey your students, ask them how well they understand, break problems into parts, or use pictures or graphs in the answer choices.
- Good sources of questions:
  - Questions your students ask you or that you overhear
  - Common analogies you use as a teacher
  - A series of connected questions to lead students through reasoning
  - Interpret graphs, data, pictures, etc.
  - Discussion questions where there is no one right answer

See also handout

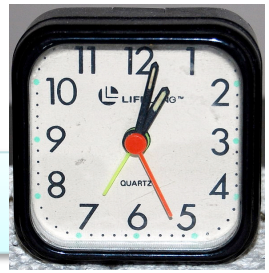
Part D: Create your own clicker question

Then share with your group

Create, rate and swap

- Use the Bloom's Taxonomy worksheet to rate the Bloom's level of your question
- Swap your question with a neighbor. Do you agree on the Bloom's level of your question?
- Use the verbs on the detailed Bloom's handout to "Bloomify up" the level of your question.

5 minutes



Part E:

What are your top three concerns regarding using clickers and peer instruction in your teaching?

Then share with your group

Share out

- What did you learn in this process?
- What worked well, what was challenging?
- How might you go about writing questions in your class?

But…

The perfect question doesn't solve all problems!

Peer Instruction Learning Mode, part 1

When your group is involved in learning, which of the following best describes how you interact:

1. I always express my opinion and then attempt to defend it.
2. I listen to the opinion of others and then enter the conversation by supporting one or another.
3. I sit back and listen to the discussion and then make up my own mind.
4. I listen to the conversation but then wait for the instructor/professor to explain the correct answer

Studio Learning Mode, part 2

Consider the different learning modes used in this studio section. Rank order the following learning modes from most to least valuable in terms of your own learning:

A. Discussing clicker questions, worksheets, and lab activities with my peers at the table

B. Discussing clicker questions, worksheets, and lab activities with the instructors (Professor, TA's, LA's) during class.

C. Hearing and thinking about the discussion and then getting the professor's description at the end.

- A, B, C
- B, C, A
- C, B, A
- A, C, B
- B, A, C
- C, A, B

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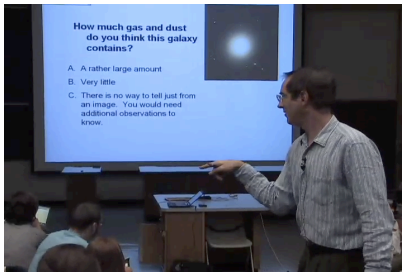
1. A, B, C
2. B, C, A
3. C, B, A
4. A, C, B
5. B, A, C
6. C, A, B

Slides about "Questioning" for Clicker Workshops



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Co-presenters have included Steven Pollock, Jenny Knight, Trish Loeblein, and Kathy Perkins.

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Credit should be given to: Stephanie Chasteen and the Science Education Initiative at the University of Colorado, http://colorado.edu/sei

Action Plan

What will you do to implement ideas you heard about in this workshop?

OR what key ideas will you share with a colleague? (See Clicker Tips sheet for summary!)

1.

2.

3.

Whiteboard