The Use of i-clickers:
to promote active and deep learning in the classroom

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When did medical education in US and Canada become 4 years?

A) 1890  
B) 1910  
C) 1930  
D) 1940  
E) 1950

What is the half-life of medical knowledge?

A) 30 years  
B) 20 years  
C) 10 years  
D) 5 years  
E) 2.5 years

Problems with Lecturing

Based on incorrect assumptions about how people learn

(Furtak, 2001)
**Typical Student Pattern**

- Take notes at lecture
- Open book to problems
- Look for equations
- Turn in problems
- Cram for test
- Take test
- Forget

(Fromak, 2001)

**Problems with Lecturing**

Student attention wanes

![Curve of Forgetting](image)

- 100% Day 1
- 50% Day 2
- 10% Day 7
- 2.4% Day 30

(Univ of Waterloo, Counseling Services)

*"If you ask students why they read the textbook, they say it's to help them understand the lectures. It should be the other way around: students should be coming to class in order to get help understanding the reading!"*  

(E. Mazur)

**What do you know about how people learn?**

A) a great deal
B) a little bit
C) not much
D) I think I heard something
E) nothing

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall Semester hrs</th>
<th>Spring Semester hrs</th>
<th>Total Hours</th>
<th>Tuition $/hour</th>
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<tbody>
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<td>308.75</td>
<td>687.75</td>
<td>$57.60</td>
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<tr>
<td>Second Year</td>
<td>381</td>
<td>308.75</td>
<td>687.75</td>
<td>$67.65</td>
</tr>
</tbody>
</table>

Consider what we pay for continuing education:

Contemporary Forums:  
$575 registration  
18 credit hours  
$31.94/hour

Are we providing value added?
**LEARNING**

Two Main Principles

1) Learning is enhanced when learners actively participate in setting educational goals

2) Feedback is necessary for learning

“Tell me and I'll forget.

Show me and I'll remember.

Involve me and I'll understand.”

- Confucius

**Why use clickers?**

- Traditional approaches

**Feedback!**

- Review previous class
- Gauge understanding during a lecture
- Determine direction of the lecture
- Motivate preparation, eg. Homework, reading

**Strategies**
Pre-Assessments:
At the beginning of a quarter or before a new topic
* What do students already know?
* What are students' misconceptions?

Which of these two objects is the symbol for the healing arts?
A) Caduceus  
B) Staff of Asclepius  
C) don't know ??

Clickers and Effective Educational Technology Practices
• Just-in-time Teaching
• Peer-to-Peer Instruction

Mid-Topic Assessments:
In the middle of mini lectures or before another concept
* Do they understand this principle?
* Can they connect this principle/idea to the previous one?
* Can they apply this concept?
* How is their thinking changing?

* Post-Assessments:
At the end of a quarter, topic, or class session
* What is their overall conceptual framework?
* Can they synthesize the concepts to solve problems?
* How had their understanding changed?

What do you know about Bloom’s Taxonomy?
A) A great deal  
B) A little bit  
C) Not much  
D) I think I heard of it before  
E) Nothing
In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of levels of intellectual behavior important in learning.

Bloom found that over 95% of the test questions students encounter require them to think only at the lowest possible level...the recall of information.

Problems with Lecturing
Promotes only lower-level learning

“While entertaining and impressing students is nice, it often does not help students [to] think critically about complex material.”
- Johnson, Johnson, & Smith (1991)

Strategies
Target Clicker Questions for Different Cognitive Levels
...........from basic recall to higher-order thinking

* Synthesis - Producing something new or original from component parts
* Evaluation - Making a judgment based on a pre-established set of criteria
* Analysis - Breaking material down into its component parts to see interrelationships/hierarchy of ideas
* Application - Using a concept or principle to solve a problem
* Comprehension - Explaining/interpreting the meaning of material
* Knowledge - Remembering facts, terms, concepts, definitions, principles

Guidelines for Item Writing

* A-type: one-best-answer
  - can assess Recall of Facts, or
  - can assess Application of Knowledge

* Address important concepts
  - not trivial
  - may be more difficult to write

* Pose a focused question
  - avoid ambiguous lead-ins

* Provide homogeneous options
  - alphabetize the options

Designing Clicker Questions

Item Writing Manual (Case, SM, Swanson, DB: 2002)

* Assessment - drives learning
  + Test recall of minutiae ... if you want students to memorize minutiae
  + Test important concepts and applications ...
    if you want students to learn and think

* Outline of lecture content (or learning objectives)
  - should outline the important clicker questions
Guidelines for Item Writing

**Question Stem: Focused and Unambiguous**

* Ask yourself: “Can this question be answered without looking at the options?”
  * The most likely diagnosis is:
  * The most likely anatomic site is:
  * The most likely cause of the patient’s condition is elevation of:
  * The most likely explanation is:

* Students should not have to guess what is being asked

**Homogeneous Options:**

* Options should be
  * All diagnoses
  * All anatomic sites
  * All neuroanatomic pathways
  * All antibiotics

* The more focused the stem:
  * the harder it is to have non-homogeneous options

Guidelines for Item Writing

**Distractors (wrong answers) Should Be:**

* Plausible, but not deceptive
* Consistent with one another
  * Same length
    * Same category (homogeneous)
    * Same perspective (e.g. positive/negative)

Guidelines for Item Writing

**Avoid Irrelevant Difficulty:**

* Long, tricky, or unnecessarily complicated stems
* Vague terms in options
  * rarely
  * usually
  * frequently
  * generally
* Absolutes
  * always, never, none
* Superfluous information

Guidelines for Item Writing

**“Gaming” the System:**

* Do not benefit “test-wise” students
* Students of 2009 and beyond
  * Medical
  * Dental
  * Vet
  * competitive professional programs
  * Are “pro’s” at test-taking
  * Compile volumes of past tests at the institution

Designing Clicker Questions

**Goal of clicker questions:**

“real-time” feedback

about Knowledge and Ability to Use It
Target Clicker Questions for Different Cognitive Levels

Knowledge - Remembering facts, terms, concepts, definitions, principles

* Acute intermittent porphyria is the result of a defect in the biosynthetic pathway for:
  A. collagen
  B. corticosteroid
  C. fatty acid
  D. glucose
  E. heme
  F. thyroxine (T4)

Target Clicker Questions for Different Cognitive Levels

Comprehension - Explaining/interpreting the meaning of material

"You can forget facts, but you cannot forget understanding."  
(E. Mazur)

Example:

Which of the following are the raw materials for photosynthesis?

A. Water, heat, sunlight
B. Carbon dioxide, sunlight, oxygen
C. Water, carbon dioxide, sunlight
D. Sunlight, oxygen, carbohydrates
E. Water, carbon dioxide, carbohydrates

Example:

Who was the first person to describe the “Placebo Effect”?

A) Dr. Louis Weinstein
B) Dr. Louis Lasagna
C) Dr. Louis Sackler
D) Dr. Louis Vuitton
E) Dr. Louis Kettering

Example:

If living cells similar to those found on earth were found on another planet where there was no molecular oxygen, which cell part would most likely be absent?

A. Cell membrane
B. Nucleus
C. Mitochondria
D. Ribosome
E. Chromosomes
An otherwise healthy 33-year-old man has mild weakness and occasional episodes of steady, severe abdominal pain with some cramping but no diarrhea. One aunt and a cousin have had similar episodes. During an episode, his abdomen is distended, and bowel sounds are decreased. Neurologic examination shows mild weakness in the upper arms. These findings suggest a defect in the biosynthetic pathway for:

A. collagen  
B. corticosteroid  
C. fatty acid  
D. glucose  
E. heme  
F. thyroxine (T₄)

<table>
<thead>
<tr>
<th>Arterial PaCO₂</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Decrease</td>
<td>decrease</td>
</tr>
<tr>
<td>B. Decrease</td>
<td>increase</td>
</tr>
<tr>
<td>C. Decrease</td>
<td>no change</td>
</tr>
<tr>
<td>D. Increase</td>
<td>decrease</td>
</tr>
<tr>
<td>E. Increase</td>
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During an operation, the arterial PaCO₂ and pH of an anesthetized patient are monitored. The patient is being ventilated by a mechanical respirator, and the initial values are normal (PaCO₂ = 40 mm Hg; pH = 7.42).

If the ventilation is decreased, which of the following is most likely to occur?

The organic chemist Auguste Kékulé struggled with how the six carbon atoms of benzene linked together. He dreams of molecules twisting and turning around like snakes. In his dream, one of the snakes swallowed its own tail and rolled around like a hoop. When Kékulé awoke, he realized that the six carbon atoms of benzene were attached to each other to form a ring. Further work showed that this was correct.

Which phase of the creative process is illustrated by this example?

A. Preparation  
B. Incubation  
C. Orientation  
D. Illumination  
E. Verification
Learning

Two Main Principles

1) Learning is enhanced when learners actively participate in setting educational goals

2) Feedback is necessary for learning

Less is More!

“Covering lots of content by lecturing... does not mean anything other than that your students have been exposed to many ideas; they could not necessarily use these ideas themselves.”

Robert G. Fuller (1994) (Furtak, 2001)

“Tell me and I'll forget.
Show me and I'll remember.
Involve me and I'll understand.”

- Confucius

http://go.tufts.edu/clickers