Crafting effective clicker questions

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Adapted from workshops developed by: Stephanie Chasteen (CU-SEI), Peter Newbury (UC San Diego), Bridgette Clarkston (formerly UBC) and Cynthia Heiner (Freie Universität Berlin)

Workshop slides will be available at http://ls-cwsei.biology.ubc.ca
Have you used peer instruction in your teaching?

a. Not at all, and I haven’t seen them used.
b. Not at all, but I have seen them used.
c. I’ve used them a few times in my class.
d. I’ve used them many times in my class.
e. I could be (should be?) giving this workshop.
## Agenda

<table>
<thead>
<tr>
<th>Time (mins)</th>
<th>Activity Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Introduction</td>
</tr>
<tr>
<td>5–10</td>
<td>Peer instruction review and components of an effective clicker question</td>
</tr>
<tr>
<td>15</td>
<td>Different types of clicker questions &amp; when to ask them</td>
</tr>
<tr>
<td>15–20</td>
<td>Create a clicker question</td>
</tr>
<tr>
<td>15–20</td>
<td>Gallery walk, give feedback, share comments</td>
</tr>
<tr>
<td>10</td>
<td>Wrap-up: reflection and feedback</td>
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<tr>
<td><strong>Total:</strong></td>
<td><strong>70–85</strong></td>
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Workshop Goals:

1) identify what makes an effective clicker question

2) become familiar with different types of clicker questions and when to use them

3) practice creating your own clicker question, sharing with the group in order to receive constructive feedback
Typical Peer Instruction Episode

1. Instructor poses multiple-choice question.
2. Students think about question on their own.
3. Students vote for an answer using clickers, coloured cards, ABCD voting cards, etc.
4. The instructor reacts, based on the distribution of votes.
What characteristics of a question would make it an effective clicker question?

Your list:

• Thought-provoking
• Promotes discussion: a non-obvious answer
• Requires reasoning to get to the right answer
• Two answers that both have reasonable arguments
• Need to analyze each option
• Addresses known misconceptions, conceptual understanding
• Moving away from definitions toward higher level questions where students have to apply, analyze, evaluate...
• Applying knowledge in a practical setting/context
• Clearly worded, unambiguous what you are asking
What makes an effective clicker question?

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Credit: P. Newbury, C. Heiner,
The molecules making up the dry mass of wood that forms during the growth of a tree largely come from where?

a) Sunlight
b) The air
c) The seed
d) The soil
Exercise 1: Brainstorm goals for clicker questions

• What are your (pedagogical) goals for using clickers in your class?
BEFORE learning
Setting up instruction
Motivate
Discover
Predict outcome
Provoke thinking
Assess prior knowledge

DURING learning
Developing knowledge
Check knowledge
Application
Analysis
Evaluation
Synthesis
Probe misconception
Exercise skill

AFTER learning
Assessing learning
Relate to big picture
Demonstrate success
Review or recap
Exit poll

Credit: Rosie Piller and Ian Beatty.
Consider the questions in your handout.

• How would you characterize this question, in terms of bloom’s taxonomy?

• In other words - what might be a pedagogical goal of using this question?

• (Some of these questions may be outside your discipline, and so this could be difficult/impossible to assess. In those cases, focus on seeing the variety of types of questions!)
<Clicker questions in handout>
The molecules making up the dry mass of wood that forms during the growth of a tree largely come from which source?

a) Sunlight  
b) The air  
c) The seed  
d) The soil
Clicker question:
Are Mitochondria Cells?

A. Yes
B. No

Credit: Robin Young

Essentials of Cell Biology Fig 1-18
Suppose you pass white light through a prism and all of the colours of the spectrum are projected on a screen. If you then put a red filter over your eye and look at the spectrum, what colours do you see?

A) you see mostly red light; the blue and green disappears
B) you see mostly blue light; the other colours disappear
C) all of the colours turn red

(Duncan)
UBC Researchers are making a whale of a news headline for their recent paper in Current Biology!

Their main findings report the discovery of:

A. a new sensory organ in blue whales.
B. a mechanosensory mechanism for blue whale lunge feeding.
C. a gigantic stretchy nerve in the mouths of blue whales.
D. a new explanation for extreme energy expenditure in blue whale lunge feeding.
If this is the phase of the Moon when it rises: what is the phase of the Moon 12 hours later?

(A)  
(B)  
(C)  
(D)  
(E)
Susan throws a ball straight up into the air. It goes up and then falls back into her hand 2 seconds later.

Draw a graph showing the velocity of the ball from the moment it leaves her hand until she catches it again.
Which one is the closest match to your graph?

A)

B)

C)

D)

E) some other graph
Which of the following is an incorrect step when using the substitution method to evaluate the definite integral

\[ \int_{0}^{4} x^2 \sqrt{1 + x^3} \, dx \]

A) \( u = 1 + x^3 \)

B) \( \frac{du}{3} = x^2 \, dx \)

C) \( \frac{1}{3} \int_{0}^{4} \sqrt{u} \, du \)

D) none of the above

(Bruff)
To minimize the work you do getting a heavy bag of groceries from the first floor to the second floor of a building, you should

A. carry the bag up the stairs
B. carry the bag up in an elevator
C. put the bag on the floor of an elevator, ride up with it, and then pick up the bag again
D. carry the bag up a ramp
E. put the bag in a cart and push it up a ramp

(Chasteen)
For the data set displayed in the following histogram, which would be larger, the mean or the median?

A) mean
B) median
C) can’t tell from the given histogram

(Peck, mathquest.carroll.edu/resources.html)
A tRNA that is loaded with phenylalanine is chemically altered so that it now is attached to arginine instead. What would you expect to happen during translation?

A. The ribosome will not accept this tRNA carrying the wrong amino acid. Protein synthesis will be delayed until a tRNA carrying the correct molecule comes along.

B. Translation will still happen normally even if the tRNA is chemically altered by having arginine added. This is due to the fact that the ribosome subunits do not check the amino acid attached to tRNA.
A subset of a population of snails is randomly isolated and placed on an island.

Would a biologist agree with the following statement?

“The survival of the snails depends on how well they can adapt to their new island surroundings.”

A. Yes
B. No
Environmental effects on microbial growth

Shown is a growth curve of bacteria growing in a flask (Flask 1). Imagine that the experiment is repeated with in Flask 2, which has TWICE as much nutrients (all other conditions being the same).

Think about how this would affect the population growth, and then draw on this graph the growth curve for the Flask 2 bacteria.
What would Flask 2’s growth curve look like?
What would Flask 2’s growth curve look like?

(This is what I drew on the document camera, based on their answers)
Can your eyes resolve things better at night or during the day?

A) you can resolve things better at night
B) you can resolve things better during the day
C) you can resolve things the same during the day and at night
What do you think is most interesting about this picture?

A) lunar eclipse
B) solar eclipse
C) cloud blocking the Sun
D) sunspots
E) other

Astronomy Picture of the Day
2011 January 5
An Example Clicker Question

Which is necessary for the evolution of a trait by natural selection?

a) The trait is present in all individuals in the population.

b) The trait increases fitness.

c) The trait is complex.

d) The trait is unique to that species.
What would happen if predators that hunted by sight were removed from this environment?

a) Non-cryptic mice would survive and reproduce better than cryptic mice.  
b) Cryptic mice would survive and reproduce better than non-cryptic mice.  
c) Cryptic and non-cryptic mice would survive and reproduce equally well.  
d) Survival and reproduction for mice with either trait would not change.
String 1 has a linear mass-density of 3.00 g/cm and string 2 has a linear mass density of 5.00 g/cm. They are under tension due to a hanging block of mass $M = 500$ g. (a) Calculate the wave speed in each string.

Which equation sets up the problem correctly?

A) $T_1 + T_2 = mg$, where $T_1 \neq T_2$
B) $T_1 - T_2 = mg$, where $T_1 \neq T$
C) $2T = mg$
D) $2T = -mg$
E) choices C & D are correct because we are only concerned with magnitude
A tweet from a UK Biologist ignited a twitter firestorm this week.

The message was concerning ...

A. striking cuts in federal funding for basic research.
B. a major discovery in how to reverse aging.
C. the announcement to close a major research institute and hospital in the UK.
D. an egregious misuse of research funds.
E. a blatantly sexist peer-review she received about her manuscript.
Megan’s drop-in office hours:
When is the best time for you?

A. Tuesdays 2pm-4pm
B. Mondays 10am-1pm
C. Wednesdays 10am-1pm
D. Fridays 10am-1pm

We’ll pick the top two choices.
A transmembrane protein was synthesized in the orientation shown to the left.

Which of the following accurately depict(s) the orientation of this protein as it travels to the plasma membrane?

- None are correct!
</Clicker questions in handout>
What did you notice about the clicker questions in the handout?

• Something that was new to you?
• Something you liked?
• Something you didn’t like?
Exercise 2: Writing a question

• Choose one of the question goals, and a topic in your course.
• Write a draft question that aims to achieve this goal.
• Question goals and space for writing in your handout
• Don’t worry about writing perfect answers/distractors yet
Share your question with a neighbour

- Looking at the components that make a good question, evaluate and get feedback on your question.
### Remember components of an effective clicker question*

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*Particularly when using peer instruction
Creating *believable and useful* “distracters” for multiple choice questions

1) Talk with other instructors that have taught the course in the past.

2) Talk with your students one-on-one before class, after class, during office hours.

3) Use student responses to open-ended questions that you include in HW and exams.

4) Ask your students to come up with answers that will be used as the choices.

5) Use researched and documented student misconceptions.

Credit: D. Duncan, Univ. of Colorado
Exercise 3: Revisit your question

• Continue writing your question using what we’ve just talked about and the “tips” in your handouts
• Talk with a different neighbour and get them to try your question (especially if they are in your discipline!)
Share-out

• What did you learn from writing and revising your own question?
• What worked well, what was challenging about writing a question?
• How might you go about writing questions in the future?
Final point to consider:
Use questions at a variety of cognitive depth

Do the questions you use intellectually challenge your students or simply assess their factual knowledge?
(Depending on time/interest)

Gallery Walk

• Circulate and look at the questions around the room.

• Try to identify a suitable goal for each question. Jot any ideas down on the sheet.

• Note any question types you’d like to try. When to use? For what purpose?
Resources:

Clicker resource guide
(CU-SEI, CWSEI)

Going beyond multiple choice?
Talk with Mark Blaser about Learning Catalytics!

Eric Mazur
(1996)

Derek Bruff
(2009)

Doug Duncan
(2004, 2005)
Thank you. Questions?

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Workshop slides will be available at:
http://ls-cwsei.biology.ubc.ca

Resources!
http://cwsei.ubc.ca/resources/index.html