

## Teaching with Clickers and Classroom Voting

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## Agenda

- More Frequently Asked Questions
- Selecting (and Writing) Good Questions
- Conducting Research on Classroom Voting

Slides are / will be available from

<http://derekbruff.com/research/clickers.htm>

## More Frequently Asked Questions

## Time and Effort?

- Technology: 30 minutes with support, ½ day on your own
- Technical Problems: varies, often by system
- Getting Questions: many libraries
- Using Questions: better with practice
- Writing Questions: time consuming

## Student Response?

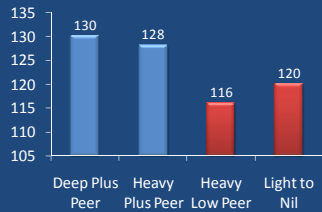
- Students generally like using clickers.
  - Makes class more interactive and fun
  - Provides useful feedback on their learning
  - Enables students to participate anonymously, avoiding peer pressure to look smart
- Students can grumble if...
  - Clickers are used only to save the instructor's time
  - Questions don't help prepare students for exams
  - Clickers aren't used regularly
  - Students are resistant to active learning

## Alternate Uses?

- Quizzes and Tests
- Homework Collection
- Classroom Games
- Classroom Experiments
- Monitoring Questions
  - How many hours did you spend working on this week's homework assignment?
  - How do you typically study for an exam in a mathematics course?

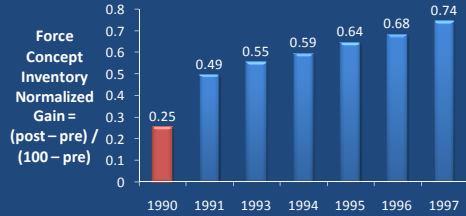
## Research on Classroom Voting?

- Miller, Sanatana-Vega, & Terrell (2006) – Cornell Univ., 330 students, 17 sections of calculus, 14 instructors, common exams



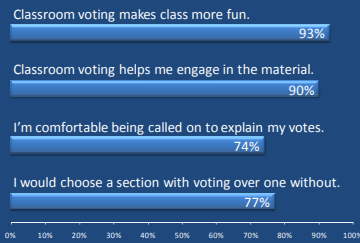
## Research on Classroom Voting?

- Crouch & Mazur (2001) – Harvard Univ., calculus-based physics courses, started using peer instruction in 1991



## Research on Classroom Voting?

- Project Math QUEST Student Surveys – 513 students, 26 courses, 14 instructors, 10 schools



## More Questions?

## Selecting (and Writing) Good Questions

## Things to think about when selecting questions

- Where does this question fit in my class period – what must I tell the students before they can answer this?
- Is this question likely to promote discussion among students? Why?
- Is this question likely to provide useful information about student learning? Why?
- What cognitive skills will students need to answer this question?

## More Examples

### An Evolution of a Question

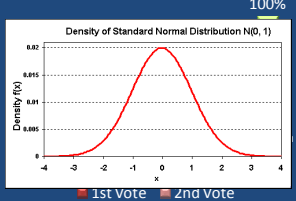
Let  $Z$  be a standard normal random variable.  
Which of the following probabilities is the smallest?

A.  $P(0 < Z < 2.07)$

B.  $P(-0.64 < Z < -0.11)$

C.  $P(Z > -1.06)$

D.  $P(Z < -0.88)$



100%

Source: Derek Bruff, Vanderbilt University

### An Evolution of a Question

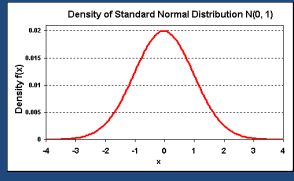
Let  $Z$  be a standard normal random variable.  
Which of the following probabilities is the smallest?

A.  $P(-2 < Z < -1)$

B.  $P(0 < Z < 2)$

C.  $P(Z < 1)$

D.  $P(Z > 2)$



Source: Derek Bruff, Vanderbilt University

### Conceptual Questions

Following an example in which a 95% confidence interval for the mean of the population of birth weights of babies born in the US in a particular year was found to be (6.85, 7.61):

- Is it correct to say that 95% of all birth weights will be between 6.85 and 7.61 pounds?
- Is it correct to say that there's a 95% chance that  $\mu$  is between 6.85 and 7.61?

Source: Derek Bruff, Vanderbilt University

### Procedural Questions

Write the formula for the following sequence (starting with  $n = 1$ ):  
1, -3, 9, -27, 81, ...

1.  $a_n = -3n$     3.  $a_n = -3^n$

2.  $a_n = (-3)^{n+1}$     4.  $a_n = (-3)^{n-1}$

Source: Angela Sharp, University of Minnesota-Duluth

### Procedural Questions

3. Which of the following is an incorrect step when finding the definite integral  $\int_0^1 x^2 \sqrt{1+x^3} dx$  by the substitution method.

a  $u = 1 + x^3$

b  $\frac{du}{3} = x^2 dx$

c  $\frac{1}{3} \int_1^{65} \sqrt{u} du$

d  $\frac{1}{3} \int_0^4 \sqrt{u} du$

e none of the above

Source: Adam Lucas, St. Mary's College of California

## One-Best-Answer Questions

2. Which is the best substitution  $u$  for the antiderivative  $\int \frac{\cos(\sqrt{\theta})}{\sqrt{\theta} \sin^2(\sqrt{\theta})} d\theta$ ?

**a**  $u = \sin^2(\sqrt{\theta})$

**b**  $u = \sqrt{\theta}$

**c**  $u = \cos(\sqrt{\theta})$

**d**  $u = \sin(\sqrt{\theta})$

**e** none of the above.

Source: Adam Lucas, St. Mary's College of California

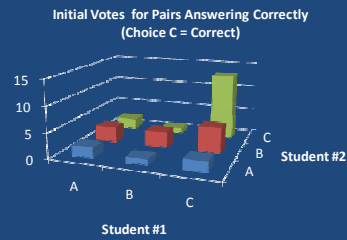
## Conducting Research on Classroom Voting

### Research Ideas – Low-Lying Fruit

- Put several questions from class on exams and compare results to exam questions not based on clicker questions
  - Ex: Crossgrove & Curran (2008)
- Keep data for two or three class sections and study characteristics of questions that lead to certain vote distributions or certain kinds of class discussions

### Research Ideas – Low-Lying Fruit

- If using two-cycle voting, compare first and second round votes



Response Data: Dennis Jacobs, Chemistry, Univ. of Notre Dame

### Research Ideas – Student Perceptions

- Survey students about their experiences with classroom voting
  - Ex: Graham et al. (2007), Nagy-Shadman & Desrochers (2008), and Trees & Jackson (2007)
- Conduct student focus groups to identify the positive and negative aspects of classroom voting

### Research Ideas – “Control Group” Experiments

- Teach two sections of the same course, varying your approach to classroom voting in each
- Potential variables include...
  - Individual voting prior to peer instruction
  - Instructions to students for peer instruction
  - Display of results prior to discussion
  - Correct answer indicator prior to discussion
  - Types of clicker questions
  - Grading schemes
  - Low-tech alternatives to clickers (e.g. flash cards)

## Research Ideas – Uncovering Student Thinking

- Use clicker results to identify key misconceptions – maybe follow up with focus groups to study the issues
- Analyze responses to free-response questions for common misconceptions useful in writing multiple-choice questions
- Audio or videotape small-group or classwide discussions and analyze these conversations for patterns in student thinking

## Where to Publish

- Mathematics Teaching Journals
  - *PRIMUS*
  - *ICTCM Proceedings*
  - *Mathematics and Computer Education*
  - *MAA Innovative Teaching Exchange*
  - *Journal of Statistics Education*
- Multidisciplinary Teaching Journals
  - *Active Learning in Higher Education*
  - *College Teaching*
  - *International Journal for the Scholarship of Teaching and Learning*
  - *Innovative Higher Education*
  - *Journal on Excellence in College Teaching*

## Your Ideas?

- What questions would you like to investigate?
  - Why are they interesting to you?
  - Why might they be interesting to others?
  - What conjectures do you have about possible answers?
- What sources of evidence might you use to answer your questions?
  - How will you collect this evidence?
  - How will you analyze this evidence?
- What resources might you tap to assist you?
  - Within your department?
  - Outside of your department?

## Contact Information

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