Our Experience in Flipping the Classroom In Three Large First Year University Calculus Classes

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CMEF
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CMS
SMC

Our Team

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SFU

Burnaby, BC

- 23,000 undergraduate students

- SFU is a commuter campus - 90% of students live off campus

- first year calculus: 100 - 550 students per section (large classes)

Audience poll...

Think about something you are really good at —perhaps a skill you are proud of, maybe one that advanced your career.

Now, think of how you became good at it.

Was it by...
(A) ...trial and error
(B) ...apprenticeship
(C) ...attending lectures
(D) ...family and friends
(E) ...practicing

Our Motivation
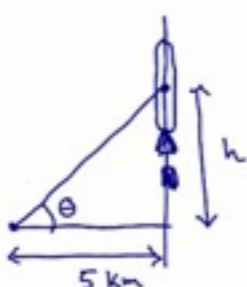
2008

- created online/distance ed. version of Calculus I
- featured pre-recorded video lectures

2010

- **Eric Mazur**
  - *Confessions of a Converted Lecturer*
  - peer instruction

Our Motivation

Two phases to education/learning:

1) transmission of information
(obtaining information)
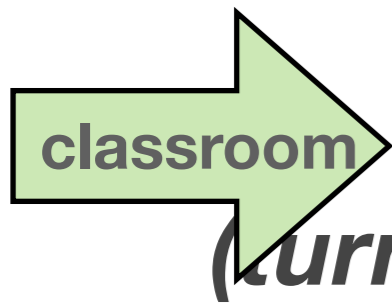
2) assimilation of information
(turning the information into knowledge)

Eric Mazur
Harvard University, Physics

Our Motivation

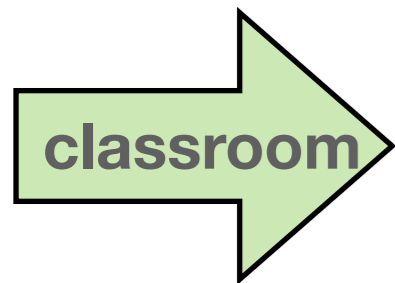**Two phases to education/learning:**

classroom →

**1) transmission of information
(obtaining information)**

home →

**2) assimilation of information
(turning the information into knowledge)**

**Eric Mazur
Harvard University, Physics**

Our Motivation

Two phases to education/learning:

home →

1) transmission of information (obtaining information)

classroom →

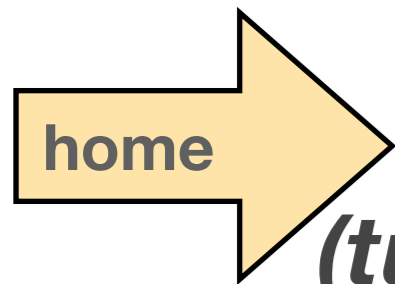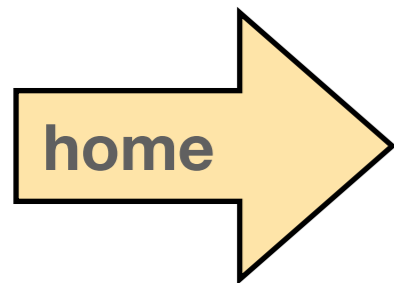**2) assimilation of information (turning the information into knowledge)**

**Eric Mazur
Harvard University, Physics**

Flipped Classroom

The classroom flip (or inverted classroom) moves the lecture outside the classroom via technology and moves homework and practice with concepts inside the classroom via learning activities.

Dr. Jeremy Strayer

Flipped Classroom

Flipped Classroom

Traditional	Flipped

Lecture

homework activities

Lecture

classroom activities

Flipped Classroom

interactive live demonstrations

pre-reading

peer instruction

pre-recorded lecture

Flipped Classroom

just-in-time teaching

online assessments & feedback

instant feedback

cooperative group problem solving
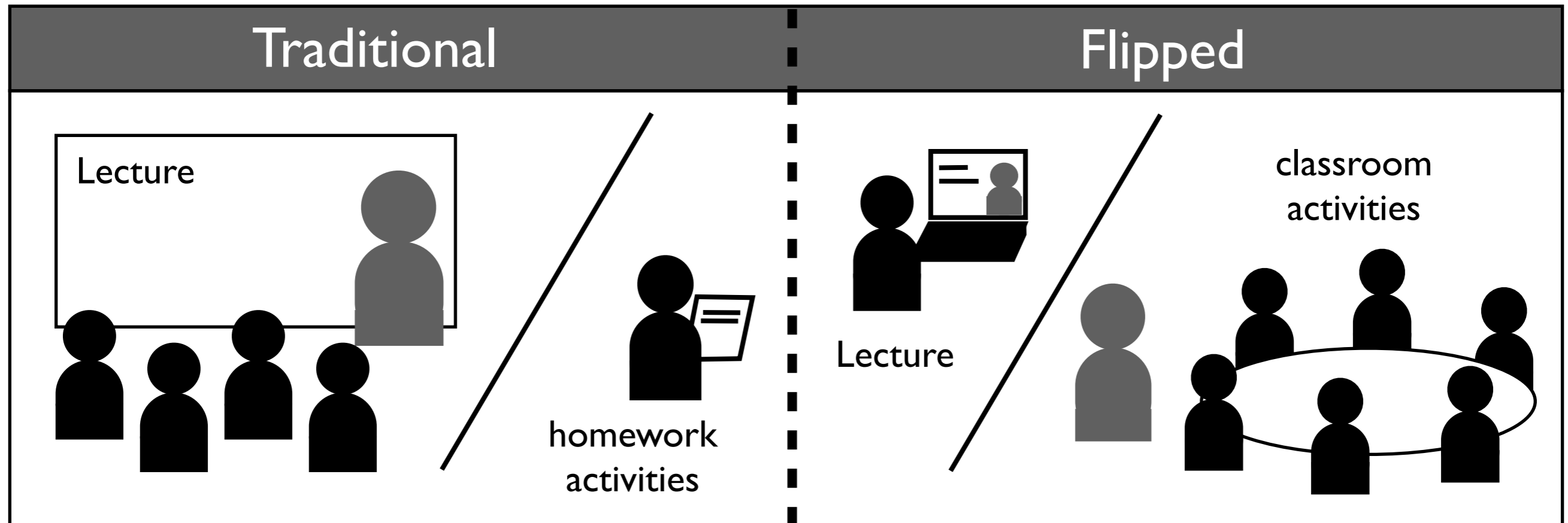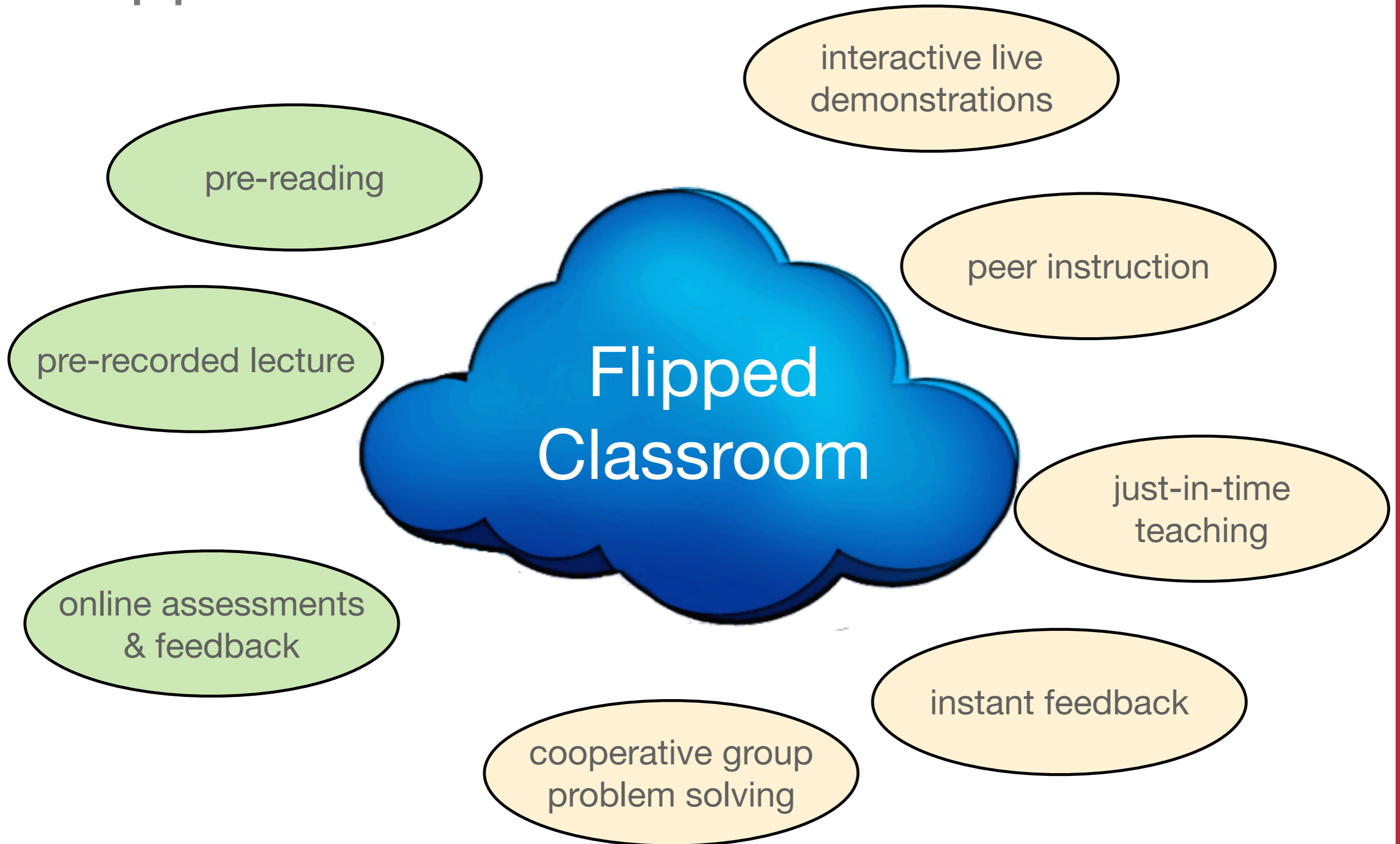
The Courses

course	title	enrollment	instructor	# flipped classes
Math 150	Calculus I: Differential Calculus with Review	110	Mulholland	9
Math 150	Calculus I: Differential Calculus with Review	220	Jungic	8
Math 151	Calculus I: Differential Calculus	342	Mulholland	9
Math 152	Calculus II: Integral Calculus	246	Mulholland	8

The Script

- **Phase 1: information gathering**

  - students watch video lecture, or read textbook

- **Phase 2: preliminary assessment**

  - students complete an online quiz

- **Phase 3: make sense of information**

  - in class, students work through problems individually and in groups (clickers, peer instruction, just-in-time teaching)

- **Phase 4: home study**

  - students continue to make sense of information by working on the weekly homework assignment

Video Demo

2.7 Derivatives and Rates of Change

1. **Quote.** "The real voyage of discovery consists not in seeking new landscapes, but in having new eyes."
(Marcel Proust , French author, 1871- 1922)

2. **Definition.** The **tangent line** to the curve $y = f(x)$ at the point $P(a, f(a))$ is the line through P with slope

$$m = \lim_{x \to a} \frac{f(x) - f(a)}{x - a}$$

provided that this limit exists.

Video Creation Tools

Hardware:

Wacom Interactive Display DTU

digital audio recorder

microphone

Green screen & light kit

Video Creation Tools

Hardware:

Interactive DTU

een screen
light kit

Video Creation Tools

Hardware:

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digital audio recorder

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Software:

LaTeX	ScreenFlow	Adobe Premiere Pro	
pdf creation	screen recording	video editing/composition	video hosting

Pre-Class Questions

Question 1   1 pts

If $\lim_{x \to a} f(x) = 0$ and $\lim_{x \to a} g(x)$ does not exist then $\lim_{x \to a} f(x)g(x)$

(A) is 1

(B) is 0

(C) is ∞

(D) does not exist (and isn't ∞)

(E) not enough information is given

○ A

○ B

○ C

○ D

○ E

Pre-Class Questions

Question 1   1 pts

For the function $f(x) = \sin(x^3 + 5x)$ determine the derivative $f'(0)$.

5   cos(5)   30   0   6   cos((x^3)+5x)*   No Answer
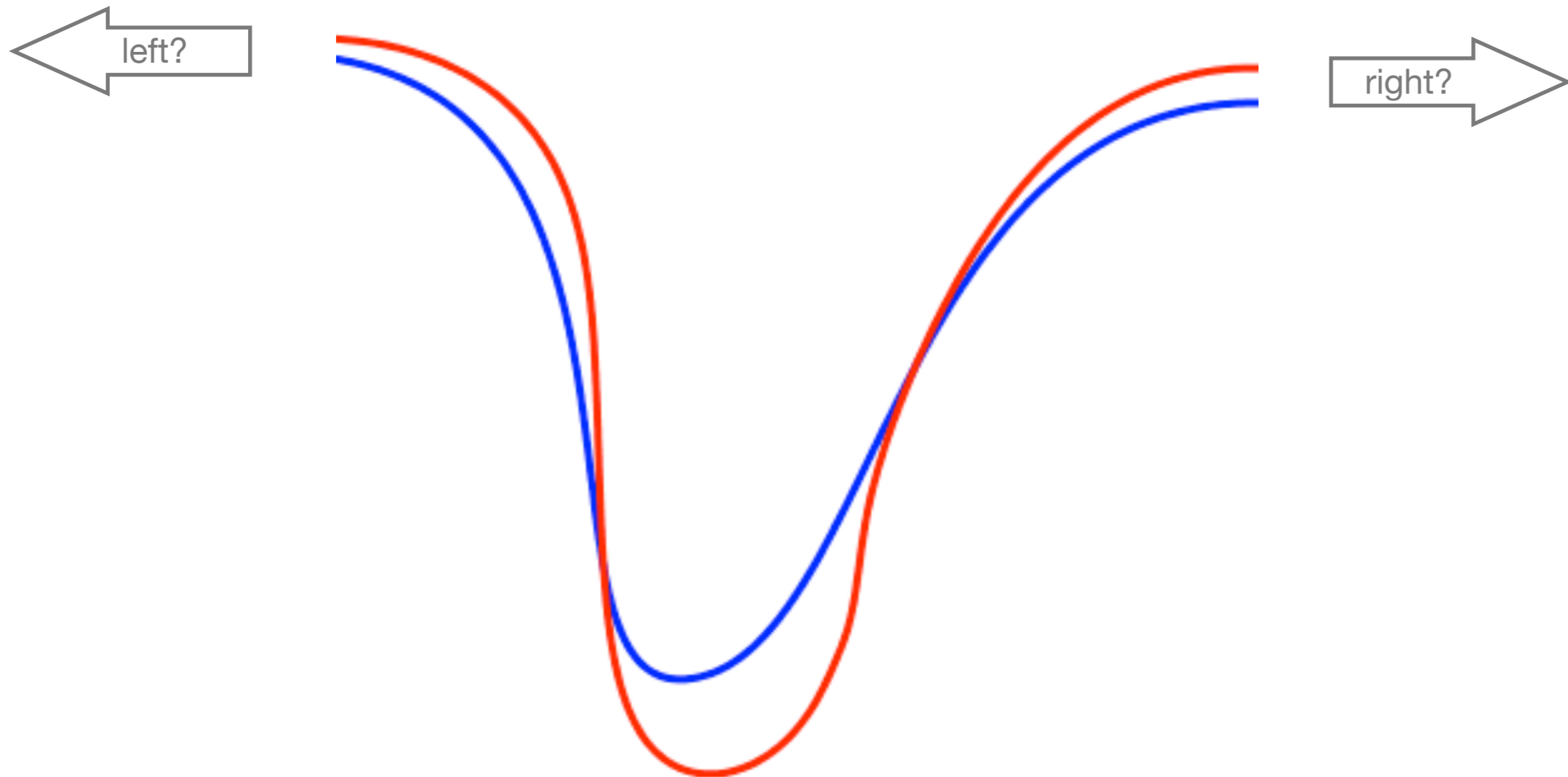   ((3x^2)+5)
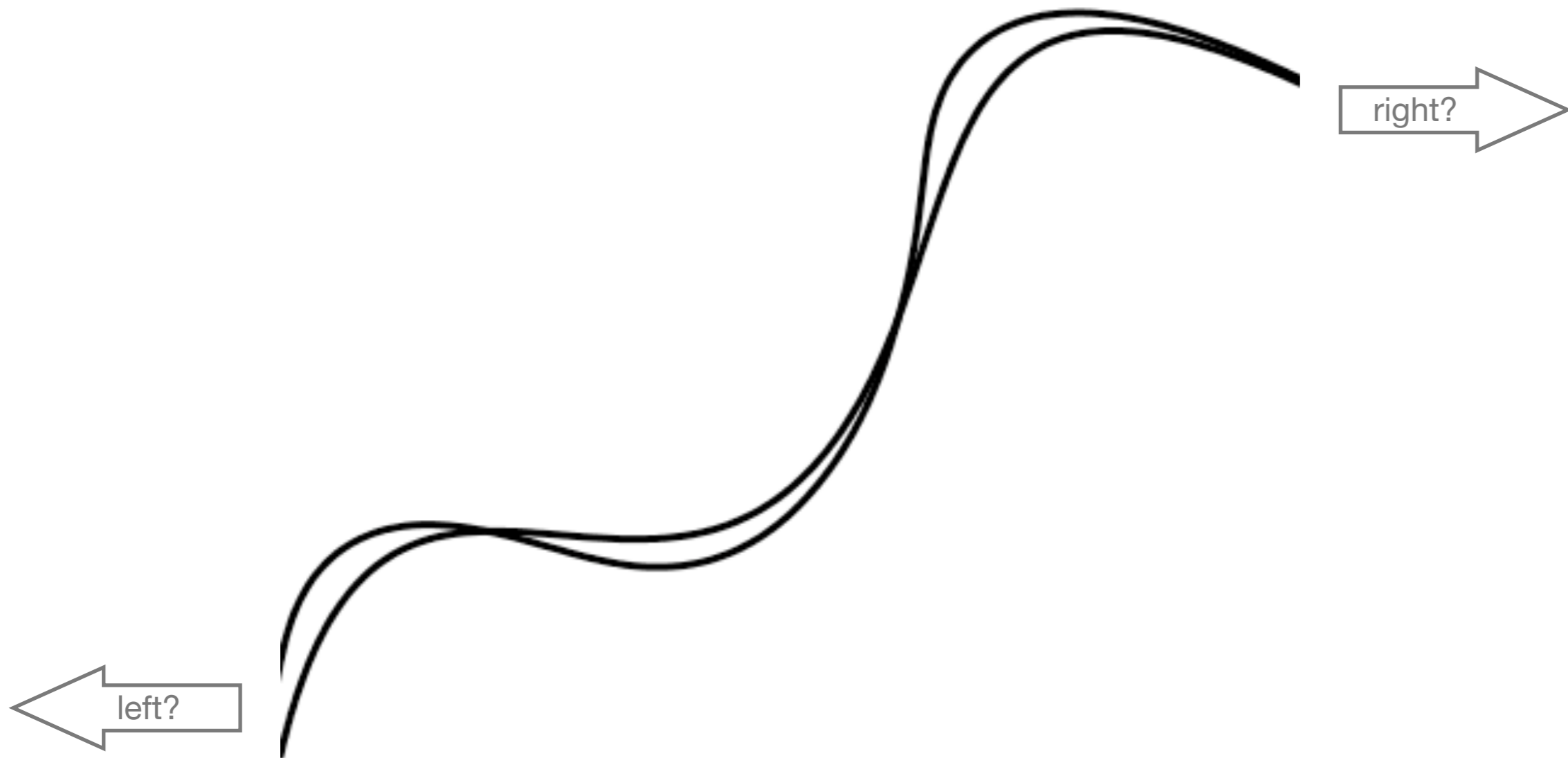
Inside the Classroom

i>clicker

Inside the Classroom

Have your clicker ready...

Which way did the bicycle go?

left?

right?

(A) The bicycle was traveling to the left.

(B) The bicycle was traveling to the right.

(C) It is not possible to determine the direction of travel.

Which way did the bicycle go?

right?

left?

(A)   The bicycle was traveling to the left.

(B)   The bicycle was traveling to the right.

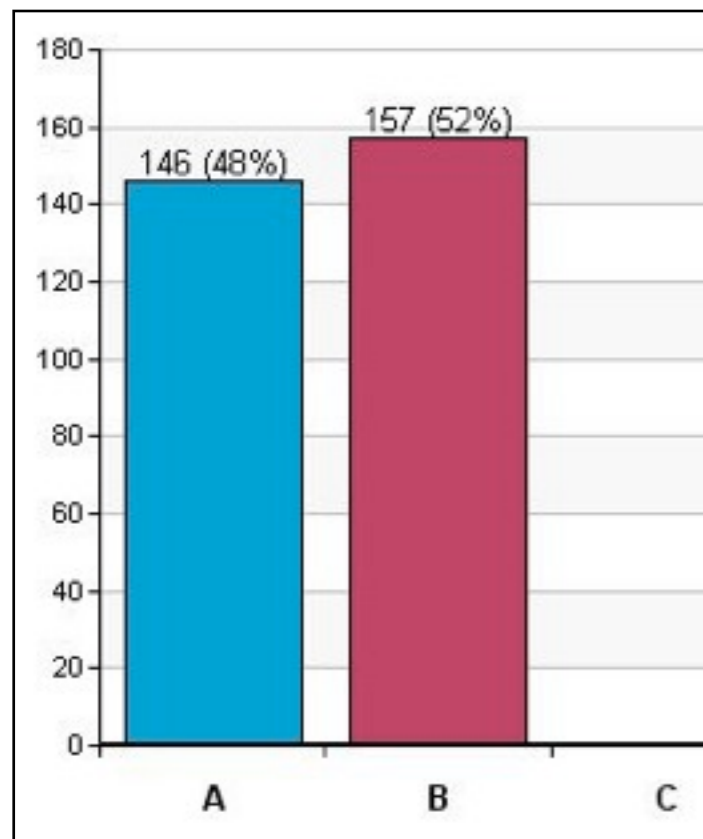(C)   It is not possible to determine the direction of travel.

Inside the classroom
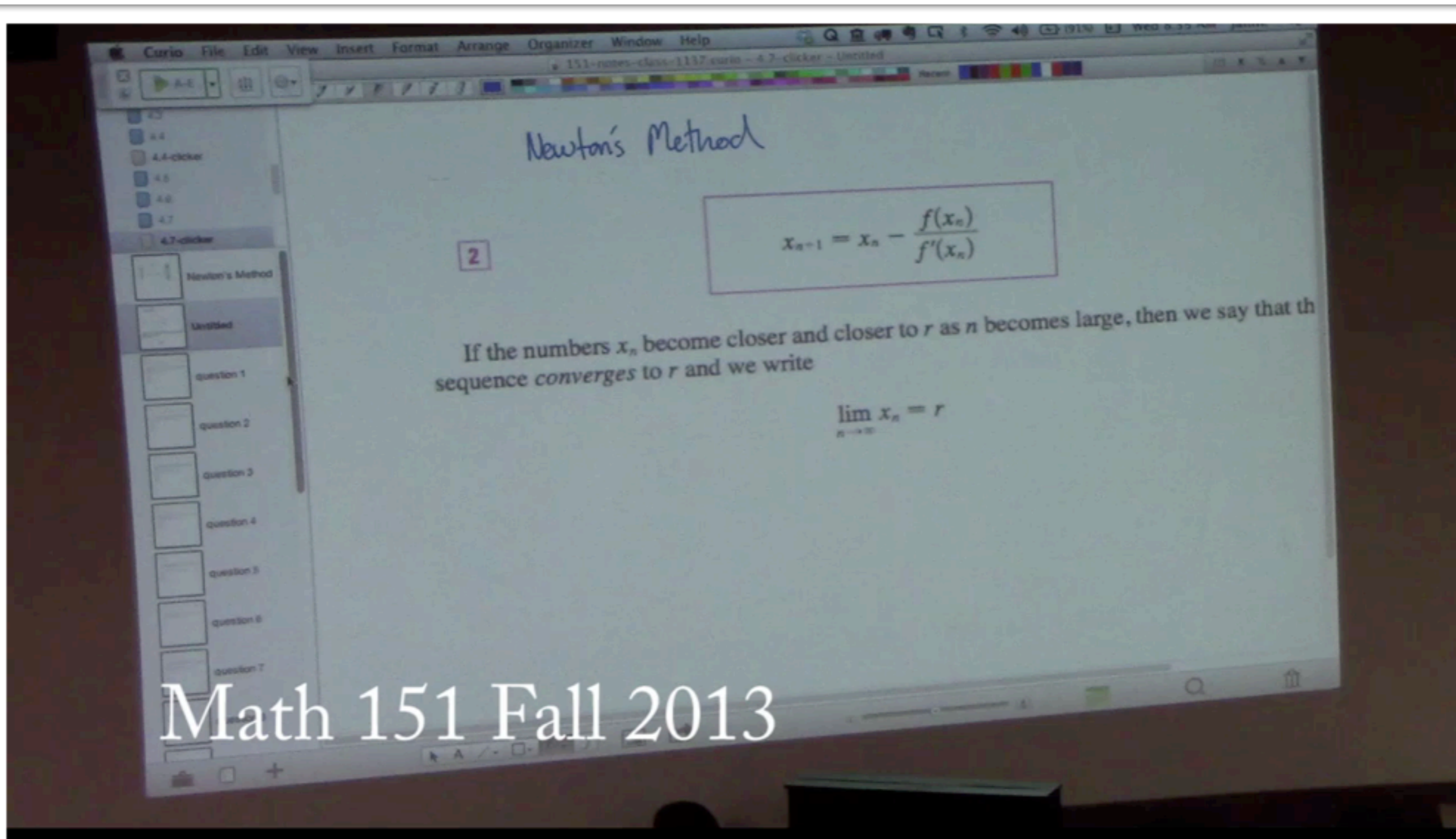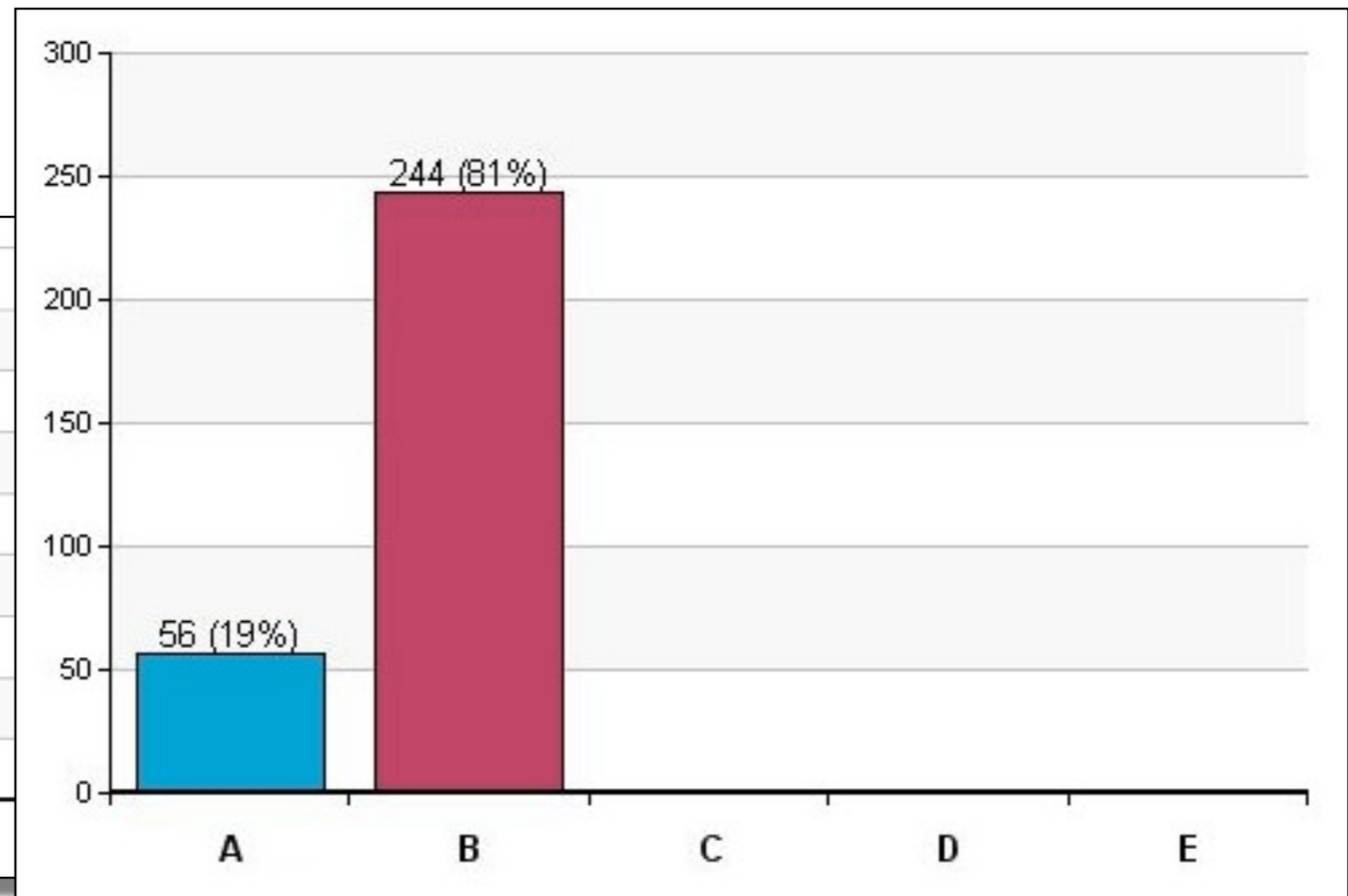

Math 151 Fall 2013

Inside the Classroom

True or **False**. If $f(x) = x^{1/3}$ then $f'(0)$ exists.

(A) True

(B) False

first round
individual

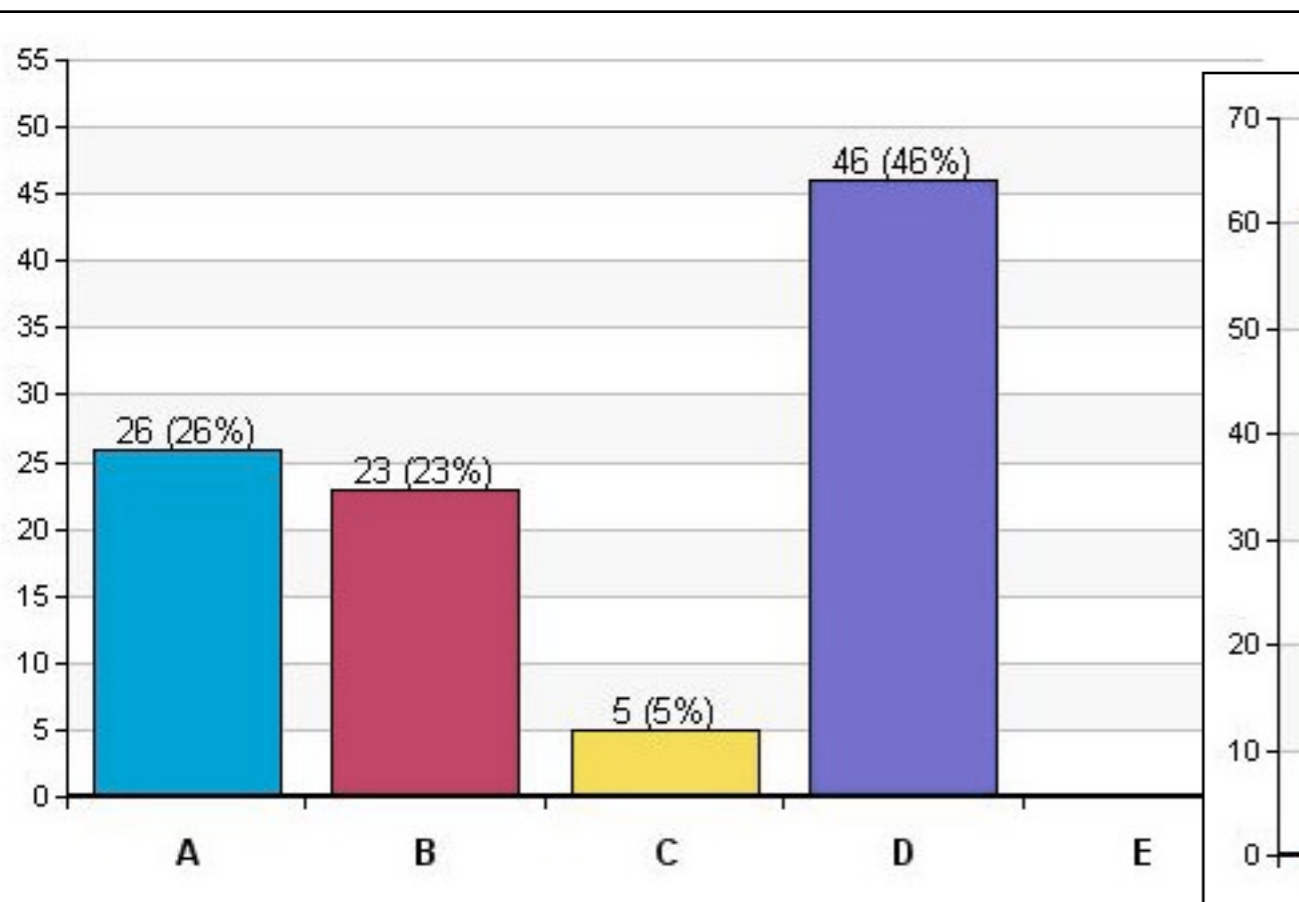second round
group

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Inside the Classroom
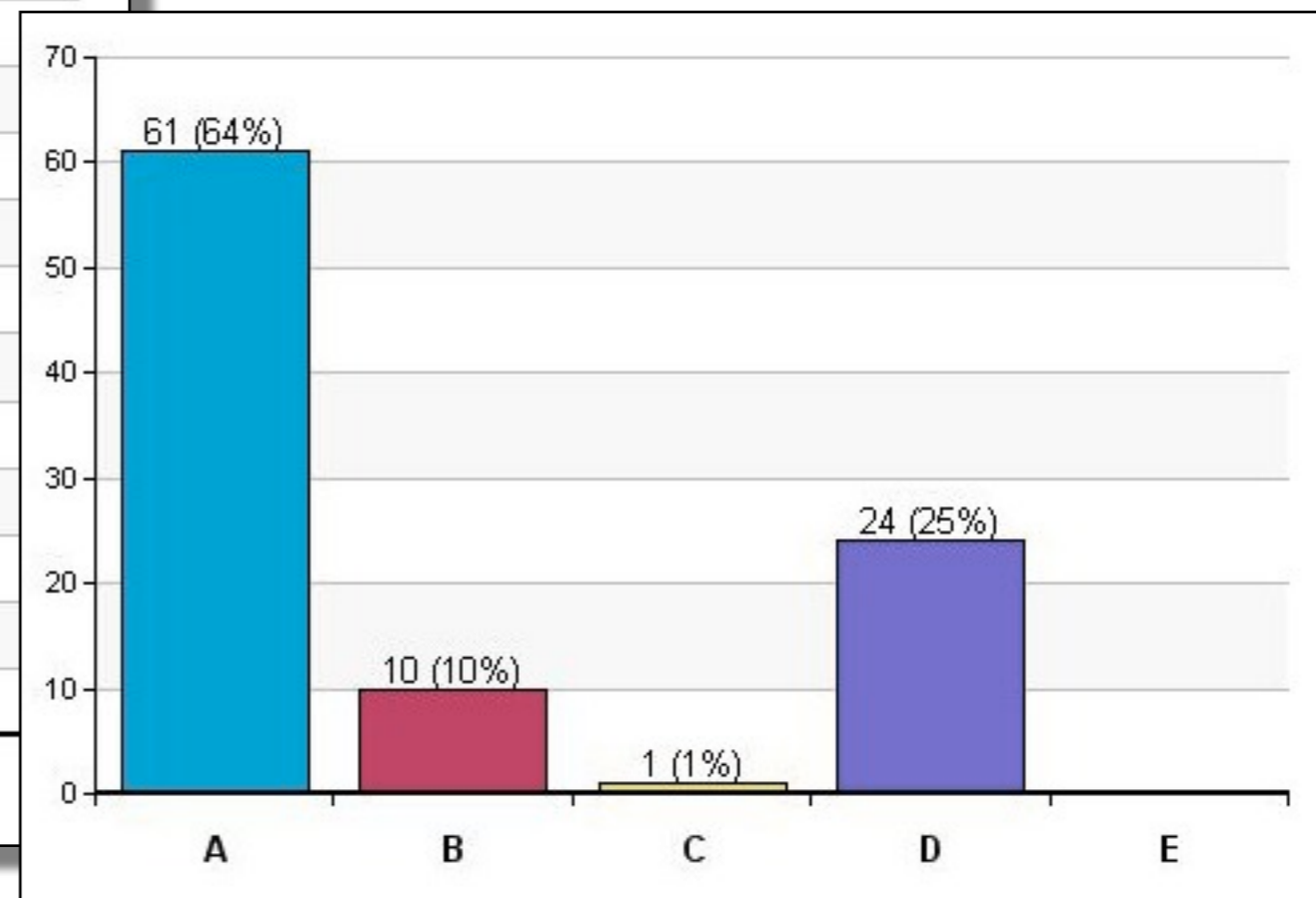
The derivative of $f(x) = x|x|$ at $x = 0$

(A) is 0.

(B) does not exist, because $|x|$ is not differentiable at $x = 0$

(C) does not exist, because f is defined piecewise

(D) does not exist, because the left and right hand limits do not agree.

first round
individual

second round
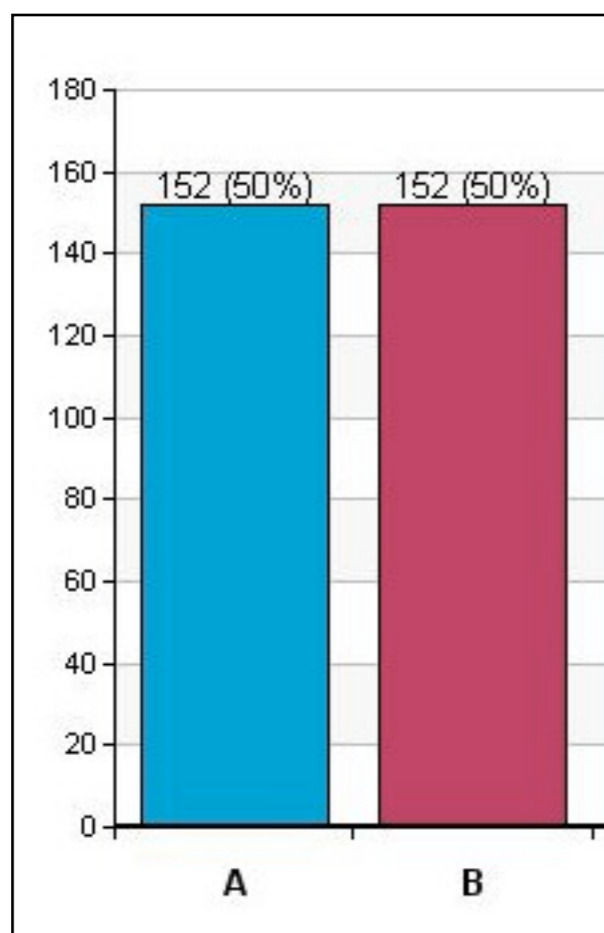group

Inside the Classroom

True or **False**.

$\lim_{x \to a} f(x) = L$ means that if x_1 is closer to a than x_2 is, then $f(x_1)$ will be closer to L than $f(x_2)$ is.

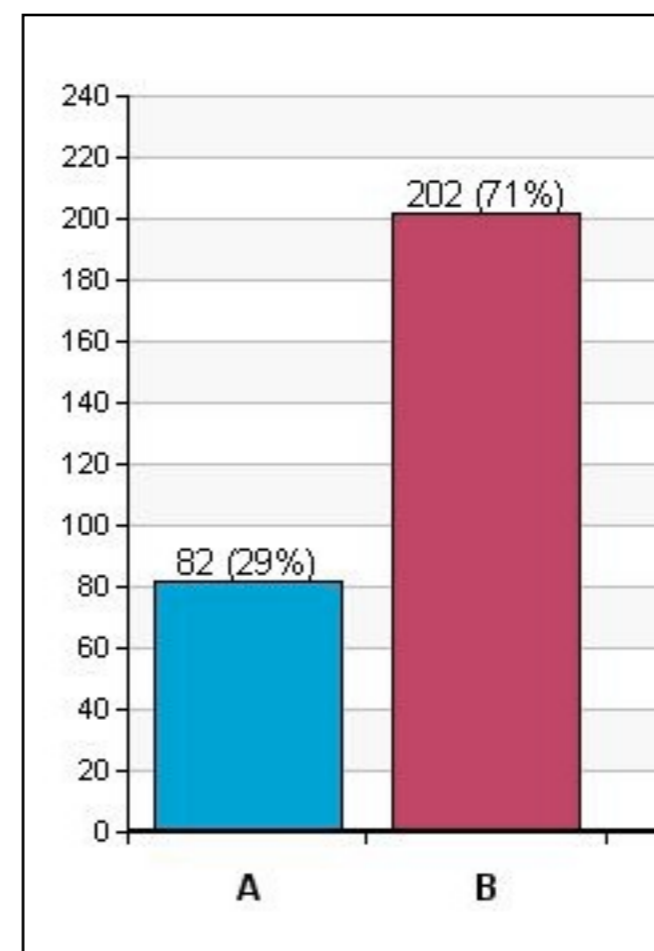Be prepared to justify your answer with an argument or counterexample.

(A) True
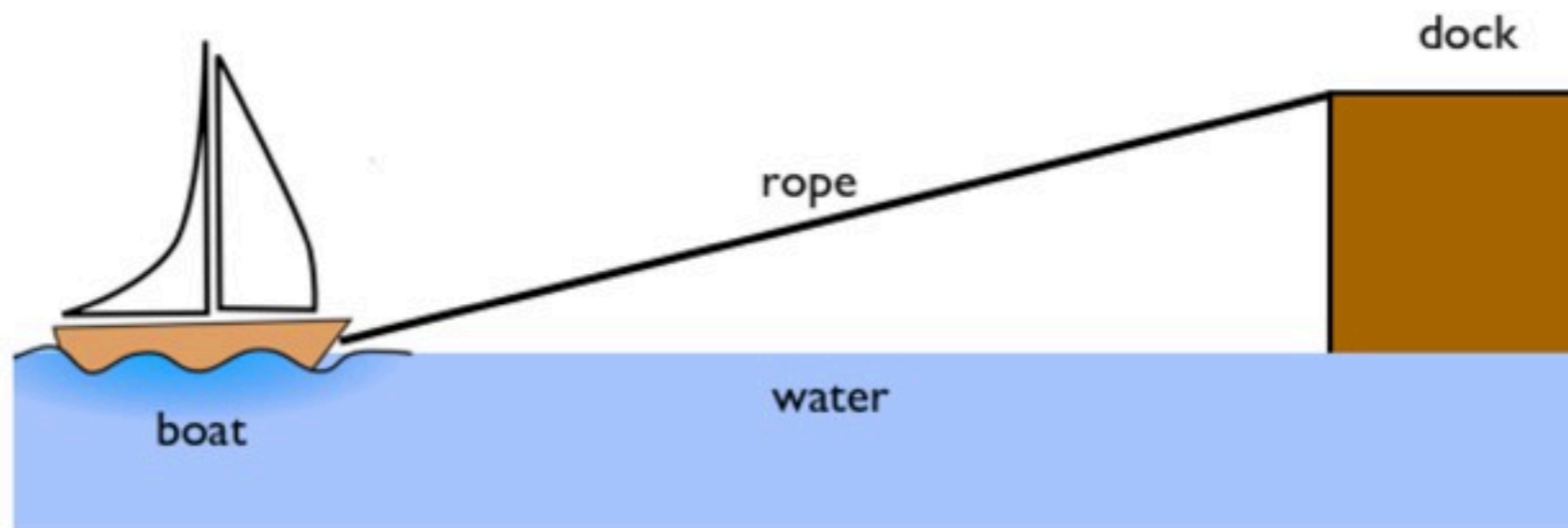
(B) False

first round individual
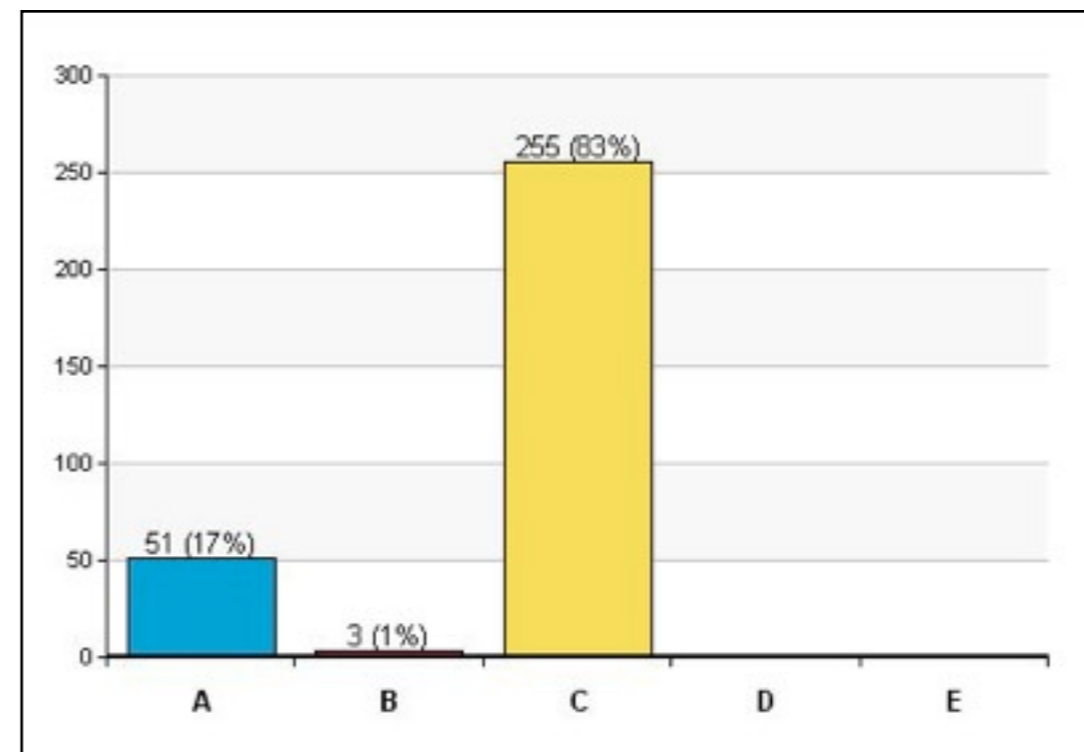

second round group

Inside the Classroom

A boat is drawn close to a dock by pulling in a rope as shown. How is the rate at which the rope is pulled in related to the rate at which the boat approaches the dock?

(A) One is a constant multiple of the other.

(B) They are equal.

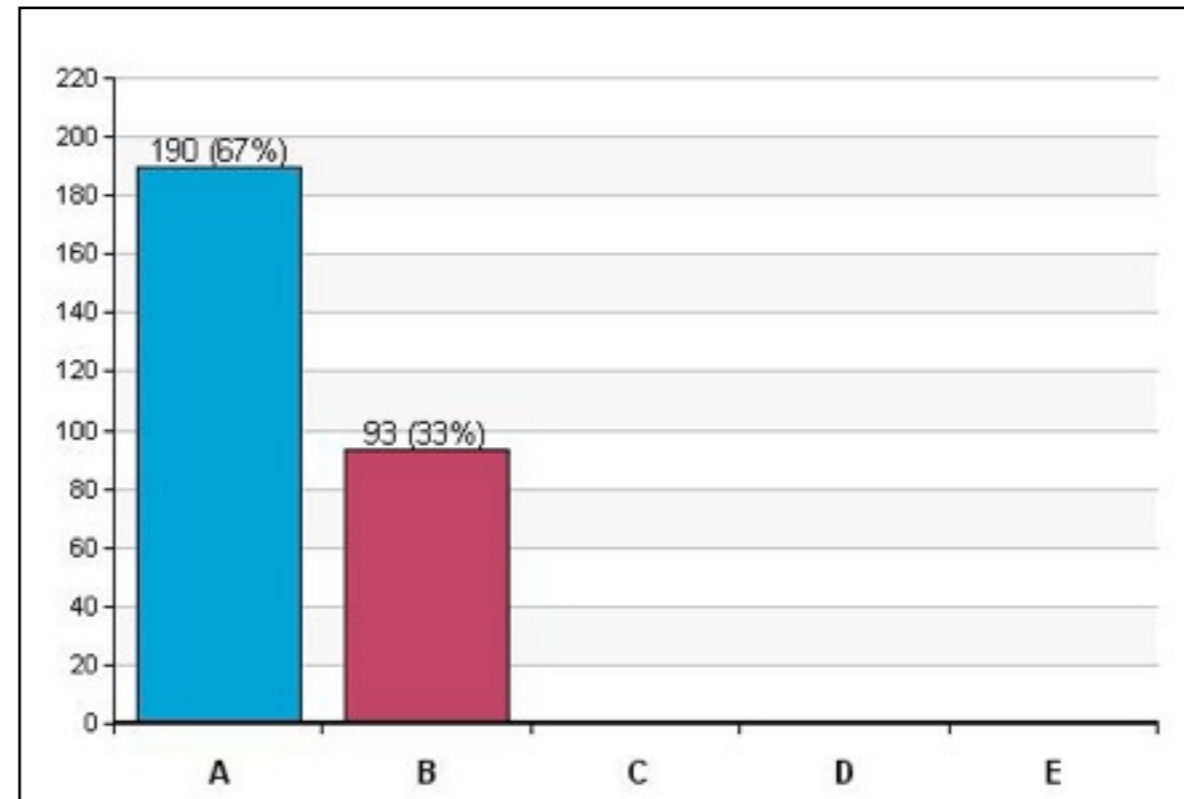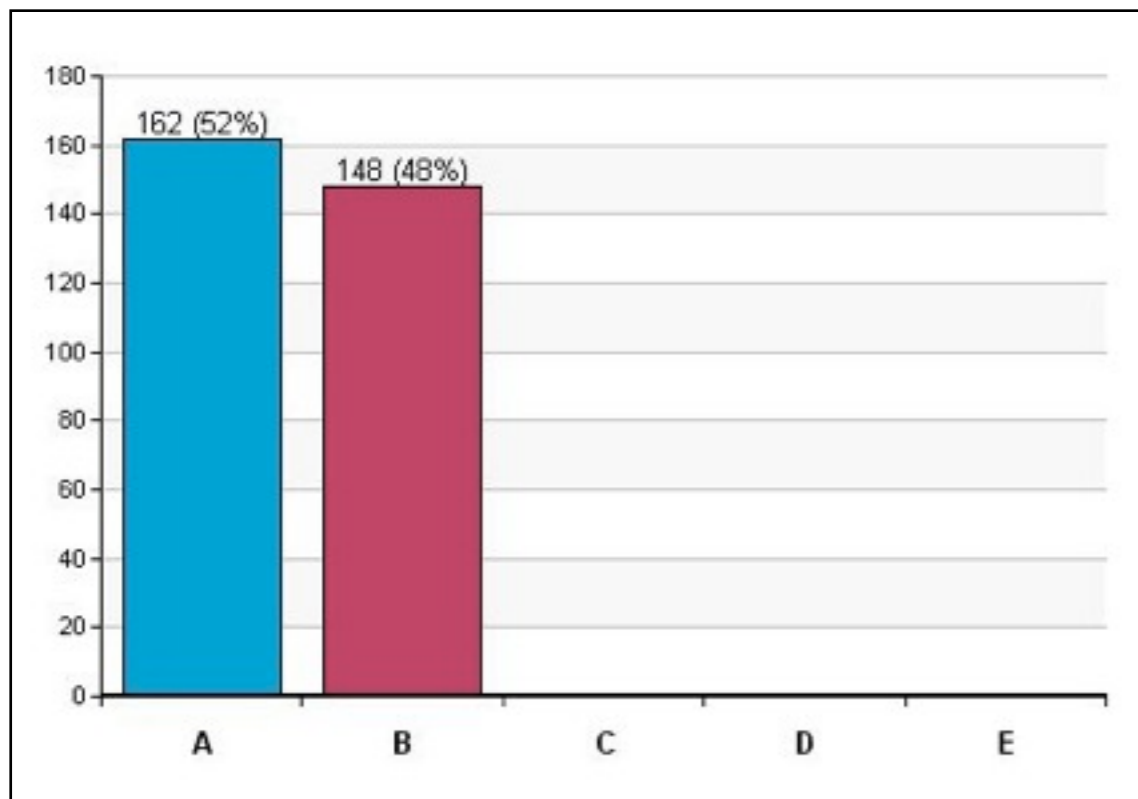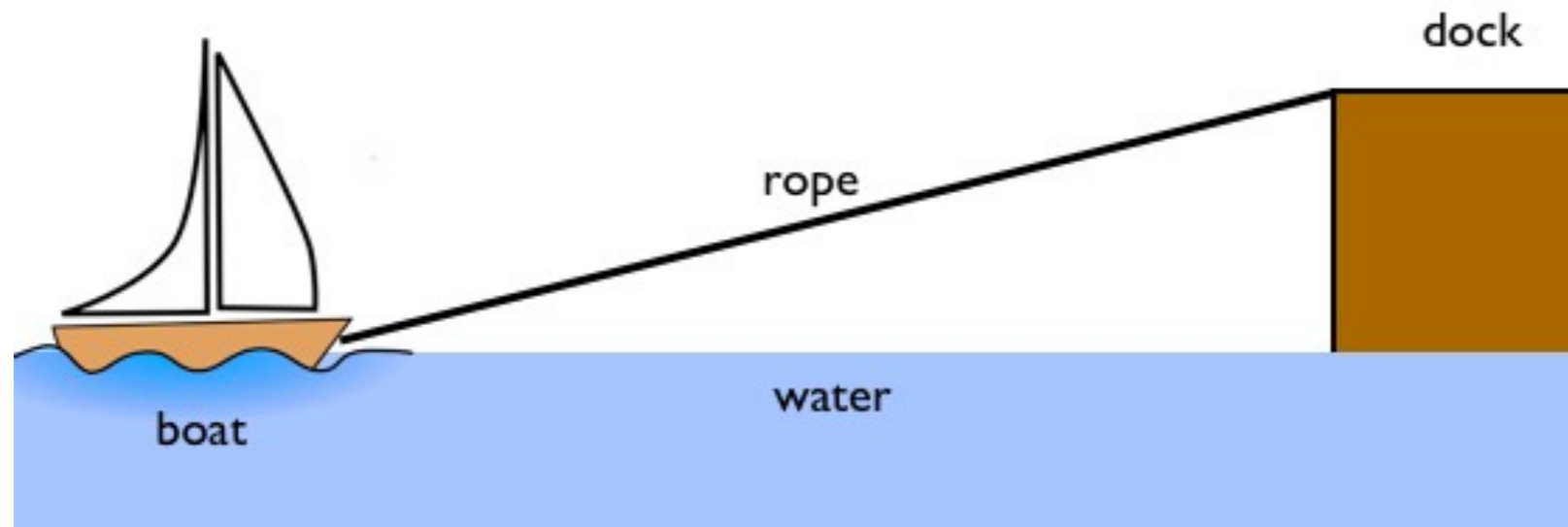(C) It depends on how close the boat is to the dock.

Inside the Classroom

A boat is drawn close to a dock by pulling in the rope at a constant rate.
True or **False**. The closer the boat gets to the dock, the faster it is moving.

(A) True
(B) False

Student Feedback

How do students feel about the flipped class?

Student Feedback

I also loved your usage of the flipped classroom learning style. I thought it was extremely conducive to learning the material. I had heard of it before this course, but I had never experienced it, and the way it was set up I thought it greatly enhanced the lessons.

Math 151 student, Fall 2013

Student Feedback

Thank you so much for all of your help and support through the semester. I have a great time in every class, especially the class on Wednesday (flipped class).

Math 150 student, Spring 2014

Student Feedback

strongly disagree = 1	disagree = 2	somewhat agree = 3	agree = 4	strongly agree = 5

question	mean
I tend to skip class because the videos are available online	1.36
I find the flipped classroom structure difficult to get used to	1.98
I take notes while watching the videos	3.72

question	mean
Making an individual response to a clicker question followed by group discussion makes me think more deeply about the question.	3.76
Having to explain my own understanding of a problem to other students helps me to learn better	4.00
It is important that the instructor explains why the correct answers to the clicker questions are correct	4.70

Student Feedback

"The major thing that I like is that you can pause the video, where you can't pause the prof."

"Make it available for other math classes"

"I think it is much more effective than just sitting in the classroom and listening to the prof while rushing to jot down some note on the topic presented"

Thank You!

Jamie Mulholland
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