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

Jamie Mulholland, Department of Mathematics, SFU
Veselin Jungic, Department of Mathematics, SFU
Cindy Xin, Teaching and Learning Center, SFU
Harpreet Kaur, Faculty of Education, SFU
Our Team

Harpreet Kaur
Education

Cindy Xin
TLC

Veselin Jungic
Math

Jamie Mulholland
Math
SFU

- 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
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

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Harvard University, Physics
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
Lecture
homework activities

Flipped
classroom activities
Lecture
Flipped Classroom

- Pre-reading
- Pre-recorded lecture
- Online assessments & feedback
- Cooperative group problem solving
- Interactive live demonstrations
- Peer instruction
- Just-in-time teaching
- Instant feedback
## The Courses

<table>
<thead>
<tr>
<th>course</th>
<th>title</th>
<th>enrollment</th>
<th>instructor</th>
<th># flipped classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 150</td>
<td>Calculus I: Differential Calculus with Review</td>
<td>110</td>
<td>Mulholland</td>
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<td>Jungic</td>
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<tr>
<td>Math 151</td>
<td>Calculus I: Differential Calculus</td>
<td>342</td>
<td>Mulholland</td>
<td>9</td>
</tr>
<tr>
<td>Math 152</td>
<td>Calculus II: Integral Calculus</td>
<td>246</td>
<td>Mulholland</td>
<td>8</td>
</tr>
</tbody>
</table>
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
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:

- digital audio recorder
- microphone
- Wacom Interactive Display DTU
- Green screen & light kit
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Hardware:
- Wacom Interactive Display DTU
- Green screen & light kit
- Canon camera
- Digital audio recorder
- Microphone

Software:
- LaTeX
- ScreenFlow
- Adobe Premiere Pro
- YouTube

- pdf creation
- Screen recording
- Video editing/composition
- Video hosting
Pre-Class Questions

Question 1

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 \( \infty \)
(D) does not exist (and isn’t \( \infty \))
(E) not enough information is given

You need to select the correct answer from the options A, B, C, D, or E.
Pre-Class Questions

**Question 1**

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

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

i>clicker
Have your clicker ready...
Which way did the bicycle go?

(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?

(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

Newton's Method

\[ x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} \]

If the numbers \( x_n \) become closer and closer to \( r \) as \( n \) becomes large, then we say that the sequence converges to \( r \) and we write

\[ \lim_{n \to \infty} x_n = r \]

Math 151 Fall 2013
Inside the Classroom

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

(A) True
(B) False
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.
**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
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
How do students feel about the flipped class?
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
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

<table>
<thead>
<tr>
<th>question</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I tend to skip class because the videos are available online</td>
<td>1.36</td>
</tr>
<tr>
<td>I find the flipped classroom structure difficult to get used to</td>
<td>1.98</td>
</tr>
<tr>
<td>I take notes while watching the videos</td>
<td>3.72</td>
</tr>
<tr>
<td>Making an individual response to a clicker question followed by group</td>
<td>3.76</td>
</tr>
<tr>
<td>discussion makes me think more deeply about the question.</td>
<td></td>
</tr>
<tr>
<td>Having to explain my own understanding of a problem to other students</td>
<td>4.00</td>
</tr>
<tr>
<td>helps me to learn better</td>
<td></td>
</tr>
<tr>
<td>It is important that the instructor explains why the correct answers to</td>
<td>4.70</td>
</tr>
<tr>
<td>the clicker questions are correct</td>
<td></td>
</tr>
</tbody>
</table>

N = 255

Strongly disagree = 1 | Disagree = 2 | Somewhat agree = 3 | Agree = 4 | Strongly agree = 5
"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
j_mulholland@sfu.ca