Outline

1. Overview of Flipped Format
   - Outside of Class
   - In Class

2. Comparisons With a Traditional Section
   - Exam Scores
   - Concept Inventories
   - Drop/Withdraw/Fail Rate
   - Student Attitudes and Feedback
   - Surprising Results

3. The Next Iteration
   - Incremental Improvements
Outside of Class

- Read assigned material from the textbook
- Watch video lectures (≈2 hr per week)
- Take a short concept quiz
- Complete weekly homework
In Class

- Review material based on results of concept quiz
- Use demonstrations and clicker questions to reinforce concepts
- Practice problem solving
- Complete a ~weekly concept-rich group problem
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Exam 1 (Vectors, Kinematics, and Forces)

Exam 1 Traditional

Exam 1 Flipped

(p<0.001)
Exam 2 (Energy, Momentum, and Rotation)

Results of Flipped Physics Comparisons With a Traditional Section

(p<0.001)
Exam 3 (Equilibrium, Oscillations, and Waves)
Final Exam (Everything Previous + Thermodynamics)

Results of Flipped Physics Comparisons With a Traditional Section

Final Exam Traditional

Final Exam Flipped

(p<0.001)
FCI (Force Concepts)

FCI Results

- Traditional
- Flipped

Average Score %

Pre Test
Post Test

+22.3%
+27.2%

(p=0.167)
FCI (Force Concepts, Binned by Pre-Score)
RRMCS (Rotation Concepts)

**RRMCS Results**

- **Traditional**
- **Flipped**

- Pre Test: +19.8%
- Post Test: +29.4%

(p=0.004)
Results of Flipped Physics Comparisons With a Traditional Section

RRMCS (Rotation Concepts, Binned by Pre-Score)

Binned RRMCS Results

- Traditional
- Flipped

<table>
<thead>
<tr>
<th>Pre Test Score</th>
<th>Post Test Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>(13) 3</td>
</tr>
<tr>
<td>20-40</td>
<td>(59) 41</td>
</tr>
<tr>
<td>40-60</td>
<td>(29) 49</td>
</tr>
<tr>
<td>60-80</td>
<td>(2) (19)</td>
</tr>
<tr>
<td>80-100</td>
<td>(0) (1)</td>
</tr>
</tbody>
</table>
**STPFASL (Thermodynamics Concepts)**

![Bar Chart]

- **STPFASL Results**

  - **Bar Chart Description**:
    - **Y-axis**: Average Score (%)
    - **X-axis**: Pre Test, Post Test
    - **Bars**:
      - Purple: Traditional
      - Green: Flipped
    - Significant improvements observed:
      - Pre Test: +9.6%
      - Post Test: +12.7%
    - (p=0.403)

**Results of Flipped Physics Comparisons With a Traditional Section**
Drop/Withdraw/Fail Rate

![Bar Charts: Traditional vs. Flipped](chart.png)

- **Traditional**
  - Dropped: 5%
  - Withdrew: 15%
  - Failed (C-): 20%

- **Flipped**
  - Dropped: 10%
  - Withdrew: 5%
  - Failed (C-): 15%

*p = 0.619*
Results of Flipped Physics Comparisons With a Traditional Section

CLASS (Overall Learning Attitudes)

CLASS Results
Overall

<table>
<thead>
<tr>
<th>Percentage of Expert-Like Responses</th>
<th>Traditional</th>
<th>Flipped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post Test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(p=0.237)
CLASS (Problem Solving Confidence)

The Only Negative Result

CLASS Results
Problem Solving Confidence

- Traditional
- Flipped

Percentage of Expert-Like Responses

(p=0.009)

Initial overconfidence, or downside to in-class problem solving?
Acceptance of the Flipped Format

I think that the flipped format worked well for this course.

I would rather take a flipped physics course than a traditional one.
Self-Reported Workload

How much time in total did you spend on this course during an average week (including time spent in class)?

- **Traditional**
  - 0-2 hours: 3 responses
  - 2-4 hours: 6 responses
  - 4-6 hours: 18 responses
  - 6-8 hours: 23 responses
  - 8-10 hours: 30 responses
  - 10-12 hours: 20 responses
  - Over 12 hours: 5 responses

- **Flipped**
  - 0-2 hours: 5 responses
  - 2-4 hours: 5 responses
  - 4-6 hours: 10 responses
  - 6-8 hours: 27 responses
  - 8-10 hours: 40 responses
  - 10-12 hours: 27 responses
  - Over 12 hours: 5 responses

(p = 0.108)
Surprising Result: Reduced Textbook Usage

How much time did you spend reading the textbook during an average week?

- **Traditional**
  - 0-0.5: 20
  - 0.5-1: 30
  - 1-2: 35
  - 2-3: 15
  - 3-4: 5
  - Over 4: 5

- **Flipped**
  - 0-0.5: 40
  - 0.5-1: 50
  - 1-2: 30
  - 2-3: 20
  - 3-4: 10
  - Over 4: 10

(p=0.012)
Surprising Result: Widespread Usage of Khan Academy

Over 50% of the students who responded listed Khan Academy
Summary of Metrics

Overall Success

- Exam scores ✓
- FCI ✓
- RRMCS ✓
- STPFASL ✓
- DWF rates ✓
- CLASS ✗
- Student Feedback ✓
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This Semester

Changes

- Minor adjustments to schedule
- Concept-rich group question moved to recitation
- Difficulty of example problems increased
- Using *Classroom Salon* for lecture videos

Collect More Data

- FCI
- RRMCS
- CLASS
- Student Feedback
Constant Acceleration

\[ a = \frac{v_f - v_i}{t} \]

So

\[ v = v_i + at \]

\[ v_{avg} = \frac{1}{t} (v_i + v_f) = \frac{x_f - x_i}{t} \]

\[ \frac{1}{t} \left( \frac{v_i + v_f}{2} \right) = \frac{x_f - x_i}{t} \]