Strategies for Success in Building Active Learning into the Large Class Setting

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Why are we still lecturing?
Three commitments: Evidence
Excellence
Humility

This session:

1. The nature of teaching has changed. What is our task?
2. How can we accomplish it?
Our task, I

What conclusions can you draw from this graph?
1. My father finished medical school in 1946. Penicillin wasn’t widely available in the U.S. until ~1948. What did he learn in school?

2. When I learned CPR, we were taught to do 15 chest compressions and then 4 breaths. If you didn’t do this correctly, you failed the certification test. Recent data suggest that CPR consisting ONLY of chest compressions is dramatically more effective in saving lives than the system I learned. What do you conclude from these observations?
Our task, III

The goal:

- **Imagination**
  - rudderless
  - Stay on the 45°
  - Routine experts

- **Expertise**
  - Adaptive experts

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Thank you: John Bransford (pers. comm. and Bransford et al. 2000. How People Learn (NAP: WashDC)
Schwartz et al. in Mestre, ed. Transfer of Learning from a Modern Interdisciplinary Perspective.
Bloom’s taxonomy as a conceptual framework:

<table>
<thead>
<tr>
<th>Analyze:</th>
<th>Synthesize:</th>
<th>Evaluate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can I recognize</td>
<td>Can I put ideas and</td>
<td>Can I make judgments on the</td>
</tr>
<tr>
<td>underlying</td>
<td>information together to</td>
<td>relative value of ideas and</td>
</tr>
<tr>
<td>patterns and</td>
<td>create something new?</td>
<td>information?</td>
</tr>
<tr>
<td>structure?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Higher order thinking**

- Apply: Can I use these ideas in a new situation?

**Lower order thinking**

- Understand: Can I explain these ideas to someone else?
- Remember: Can I recall key terms and ideas?
51. A 68-year-old woman has the sudden onset of weakness in her right arm and leg. She can speak, but her words are not enunciated clearly. Neurologic examination 6 weeks later shows an extensor plantar reflex on the right. When she is asked to protrude her tongue, it deviates to the left, and the muscle in the left side of the tongue shows considerable atrophy. Which of the following labeled areas in the transverse section of the brain stem is most likely damaged?
Analyze: Can I recognize underlying patterns and structure?

Synthesize: Can I put ideas and information together to create something new?

Evaluate: Can I make judgments on the relative value of ideas and information?

Apply: Can I use these ideas in a new situation?

Understand: Can I explain these ideas to someone else?

Remember: Can I recall key terms and ideas?
7. A 42-year-old woman, gravida 2, para 2, comes for a routine examination. She has type 2 diabetes mellitus well controlled with glyburide. She has a history of vulvar condylomata acuminata successfully treated with laser ablation 12 years ago. She does not smoke. She drinks a six-pack of beer nightly. She is sexually active and uses a diaphragm with spermicide for contraception. Her mother had breast cancer at the age of 65 years. The patient is 157cm tall (5ft 2in) and weighs 100kg (220lb); BMI is 40 kg/m². Physical examination shows no other abnormalities. Pelvic examination shows a 2-cm ulcer on the cervix. A biopsy specimen of the cervical lesion shows invasive squamous cell carcinoma. Which of the following is the most significant predisposing factor for this patient’s cervical cancer?

(A) Alcohol use  
(B) Diaphragm and spermicide use  
(C) Heredity  
(D) Human papillomavirus infection  
(E) Obesity  
(F) Parity  
(G) Type 2 diabetes
Part 1: Defining the task

Part 2: Accomplishing the task

A case study:

How can we lower failure rates—and help capable but underprepared students—in introductory biology courses?

Research on the introductory sequence required for biology-related majors at the University of Washington:

- Bio180: evolution, Mendelian genetics, ecology
- Bio200: molecular genetics, cell biology, development
- Bio220: plant and animal physiology
Bio180 background:

<table>
<thead>
<tr>
<th></th>
<th>2000-2007</th>
<th>2008</th>
<th>2009-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students/qtr</td>
<td>340</td>
<td>390</td>
<td>700</td>
</tr>
<tr>
<td>Students/year</td>
<td>1,200</td>
<td>1,350</td>
<td>2,100</td>
</tr>
</tbody>
</table>

Most are sophomores (Chem prereq)

Gender & ethnicity: 61% female; 39% male

- 46.7% white
- 38.5% Asian-American
- 7.4% underrepresented minorities

17% EOP ~30% ESL

90% pre-grad/professional school
Bio180 performance thresholds

Advance to Bio200: minimum 1.5 (4.0 scale)

Declare major: minimum 2.5 (OR, need to average 2.0 over the series)

For the College, the department, and the students, these are the relevant criteria for failure.
Why be concerned about the failure rate?

Average % EOP students in Bio180
Spring 2002 Course design

Modified Socratic style

Student performance (does not include drops):

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.5</td>
<td>18.2%</td>
</tr>
<tr>
<td>&lt; 2.5</td>
<td>44.8%</td>
</tr>
</tbody>
</table>
Spring 2003 Course Design:

Modified Socratic + 3-5 daily, active-learning exercises in class

• think/pair/share: state a hypothesis, make a prediction, interpret a graph

• exam-style questions: work, give answer, discuss

• minute papers (handed in but not graded): muddiest point, write an exam question

• case studies on tough topics: informal groups

• in-class demonstrations with student participation
# Spring 2003 Course Design Results

**Student performance:**

<table>
<thead>
<tr>
<th></th>
<th>Spr ‘02</th>
<th>Spr ‘03</th>
</tr>
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<tbody>
<tr>
<td>&lt; 1.5</td>
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<tr>
<td>&lt; 2.5</td>
<td>44.8%</td>
<td>42.3%</td>
</tr>
</tbody>
</table>
**Who is failing, and why?**

Analyze 3,338 students in Bio180/200/220, 2001-2005

<table>
<thead>
<tr>
<th>Gender</th>
<th>H.S. GPA</th>
<th>UW ChemGPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>SATverbal</td>
<td>TOEFL score</td>
</tr>
<tr>
<td>Classrank</td>
<td>SATquant</td>
<td>EOP standing</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>UW GPA</td>
<td>Math placement</td>
</tr>
</tbody>
</table>

We use a regression model to predict student grades in Bio180.

Michael Griego

Deb McGhee
Spring 2005 Course design

Modified Socratic + 3-5 ENFORCED daily questions + weekly, peer-graded practice exam

Section A:
  Cards + practice exam done individually

  Cards + practice exam done in a group
  (Structured groups: 1 low-risk, 2 medium-risk, 1 high-risk)

Section B:
  Clickers + practice exam done individually

  Clickers + practice exam done in a group
Spring 2005 Results

Student performance:

<table>
<thead>
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<th>Spr ‘05</th>
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<td>10.9%</td>
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<td>44.8%</td>
<td>42.3%</td>
<td>37.9%</td>
</tr>
</tbody>
</table>

- Total exam points increased by an average of 14
- Median on identical midterm (spring ’03) increased by 7 points
Fall 2005 Course design

Question: How should we grade clicker points?

Modified Socratic + 3-5 daily clicker questions + weekly practice exam

Section A: Clicker points for right/wrong answers

Section B: Clicker points for participation
# Fall 2005 Results

Student performance:

<table>
<thead>
<tr>
<th></th>
<th>Spr ‘02</th>
<th>Spr ‘03</th>
<th>Spr ‘05</th>
<th>Fall ‘05</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.5</td>
<td>18.2%</td>
<td>15.8%</td>
<td>10.9%</td>
<td>11.7%</td>
</tr>
<tr>
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<td>42.3%</td>
<td>37.9%</td>
<td>39.3%</td>
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Total exam points increased by an average of 12 over Spr ’02, Spr ’03
Fall 2007 Course design

Questions:

1. Was failure rate lower because the class was half the size?
2. Will even more structure help high-risk students?
3. Do EOP/URM students benefit most from group or individual practice?

“No lecturing” + ~4 daily clicker questions + weekly practice exam + daily reading quiz + weekly notes check + some random call during class

Half the students did the weekly practice exam online
Half the students did the weekly practice exam in structured groups
## Fall 2007 Results

Student performance:

<table>
<thead>
<tr>
<th></th>
<th>Spr ‘02</th>
<th>Spr ‘03</th>
<th>Spr ‘05</th>
<th>Fall ‘05</th>
<th>Fall ‘07</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.5</td>
<td>18.2%</td>
<td>15.8%</td>
<td>10.9%</td>
<td>11.7%</td>
<td>7.4%</td>
</tr>
<tr>
<td>&lt; 2.5</td>
<td>44.8%</td>
<td>42.3%</td>
<td>37.9%</td>
<td>39.3%</td>
<td>33.9%</td>
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Does group work benefit high-risk students?
Fall 2009 Course design

Questions:

1. Can we implement a highly structured course design in an EXTREMELY large-enrollment course? (700 students)

2. And live to tell the tale?

No lecturing (at all) + ~4 daily clicker questions + weekly practice exam + daily reading quiz + ~15 random call exercises in class
# Fall 2009 Results

Student performance:

<table>
<thead>
<tr>
<th></th>
<th>Spr ‘02</th>
<th>Spr ‘03</th>
<th>Spr ‘05</th>
<th>Fall ‘05</th>
<th>Fall ‘07</th>
<th>Fall ‘09</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.5</td>
<td>18.2%</td>
<td>15.8%</td>
<td>10.9%</td>
<td>11.7%</td>
<td>7.4%</td>
<td>6.3%</td>
</tr>
<tr>
<td>&lt; 2.5</td>
<td>44.8%</td>
<td>42.3%</td>
<td>37.9%</td>
<td>39.3%</td>
<td>33.9%</td>
<td>28.3%</td>
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Low structure | Medium structure | High structure

Why put a course point on everything? Why “enforce”? 
Are exams equivalent across quarters?

Recruit 3 experienced TAs to rank all exam questions on Bloom’s taxonomy of learning.

Weighted Bloom’s Index \(= \frac{\sum_i^n P \times B}{T \times 6} \times 100\)

<table>
<thead>
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<th>Spr ‘05</th>
<th>Fall ‘05</th>
<th>Fall ‘07</th>
<th>Fall ‘09</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Average</strong> (weighted Bloom’s index)</td>
<td>45.8</td>
<td>52.1</td>
<td>46.9</td>
<td>52.2</td>
<td>52.1</td>
<td>53.5</td>
</tr>
</tbody>
</table>
Are students equivalent across quarters?

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>2.46</td>
<td>2.57</td>
<td>2.64</td>
<td>2.67</td>
<td>2.85</td>
<td>2.70</td>
</tr>
<tr>
<td>n</td>
<td>327</td>
<td>338</td>
<td>334</td>
<td>328</td>
<td>339</td>
<td>691</td>
</tr>
</tbody>
</table>

Create a general linear model to explain actual grade, based on predicted grade and degree of structure in course.
Last question:

Did we reduce the achievement gap?

… without spending a lot more money? or maybe even less money?

2003-2008 (Aut/Win/Spr) averages: EOP v non-EOP final grade differences in UW gateway STEM courses
Is there an interaction between degree of course structure and EOP status? (many instructors)

General linear mixed-effects modeling and MMI: Best models include EOP as a fixed effect; likelihood-ratio test, \( p = 0.0027 \).
What could cause a *disproportionate* increase in performance by disadvantaged students?

The Carnegie Hall hypothesis:

How do you get to Carnegie Hall? **PRACTICE!**

… and how you practice matters:
1) high-level questions (new contexts/applications);
2) group work (teach others/explain yourself, challenge and be challenged);
3) daily/weekly basis
A clicker question from Autumn 2011: Why aren’t more professors using evidence-based teaching?

1. The data are too new—there hasn’t been time to change. 18.8 11.2
2. They don’t get rewarded for good teaching. 9.9 5.3
3. They haven’t received training in these approaches. 23.3 20.8
4. Students don’t demand it. 6.4 5.3
5. They don’t have access to the curriculum, needed, and don’t have time to create it themselves. 41.5 57.5
And as Grandpa Kent (Tenney) would say:

Have fun!