Outline

Some options:

- Let’s try it!
- Developing ConcepTests
- Feedback methods
- Research: providing the basis for change
- Problems with problems
- Resources
- Barriers to reform
Consider a rectangular metal plate with a circular hole in it.
Consider a rectangular metal plate with a circular hole in it.

When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.
Let’s try it!

The distance between the atoms increases uniformly
A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.
A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.

After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than

it was when the boulder was in the boat.
Let’s try it!

When we hold a page of printed text in front of a mirror, the text on the image in the mirror runs from right to left:

The New York Times
Let’s try it!

When we hold a page of printed text in front of a mirror, the text on the image in the mirror runs from right to left:

The New York Times

Why is it that right and left are interchanged and not top and bottom? Because:

1. the mirror is oriented vertically.
2. we have two eyes in the horizontal plane.
3. the Earth’s gravitation is directed downward.
4. a habit we have when looking at images in a mirror.
5. It only appears to run from left to right.
Consider an object that floats in water, but sinks in oil. When the object floats in water, half of it is submerged.
Consider an object that floats in water, but sinks in oil. When the object floats in water, half of it is submerged.

If we slowly pour the oil on top of the water so it completely covers the object, the object

1. moves up.
2. stays in the same place.
3. moves down.
Developing ConcepTests

Good ConcepTests:

• are based on student difficulties
• focus on single concept
• cannot be solved by “plug and chug”
• are clear and concise
• are of manageable difficulty
Developing ConcepTests

Try writing a ConcepTests on the following topic:

The acceleration due to gravity is constant
A ball is thrown downward (not dropped) from the top of a tower.

After being released, its downward acceleration is:

1. greater than $g$
2. exactly $g$
3. smaller than $g$
Feedback methods

Show of hands:

easy, but only moderately effective
Feedback methods

Flashcards: simple and effective
Feedback methods

Flashcards: simple and effective

Meltzer and Mannivanan, South Eastern Louisiana University
Feedback methods

Infrared transmitters (PRS): easy collection of data
Feedback methods

Infrared transmitters (PRS): easy collection of data

Kristy Beauvais, Concord Carlisle High School
Feedback methods

near future: wireless classroom
Research: providing the basis for change

Pre/post-testing important for:

- justifying approach
- improving implementation

Use the statement and figure below to answer the next two questions (15 and 16).

A large truck breaks down out on the road and receives a push back into town by a small compact car as shown in the figure below.

1. the amount of force with which the car pushes on the truck is equal to that with which the truck pushes back on the car.
2. the amount of force with which the car pushes on the truck is smaller than that with which the truck pushes back on the car.
3. the car's engine is running so the truck cannot push back against the car. The truck is pushed forward simply because it is in the way of the car.
4. neither the car nor the truck exerts any force on the other. The truck is pushed forward simply because it is in the way of the car.
5. After the car reaches the constant cruising speed at which its driver wishes to push the truck,
   1. the amount of force with which the car pushes on the truck is equal to that with which the truck pushes back on the car.
   2. the amount of force with which the car pushes on the truck is smaller than that with which the truck pushes back on the car.
   3. the car's engine is running so the truck cannot push back against the car. The truck is pushed forward simply because it is in the way of the car.
   4. the car's engine is not running so the truck cannot push back against the car. The truck is pushed forward simply because it is in the way of the car.
Evaluate assessment by comparing student performance on various kinds of problems
Research: providing the basis for change

ConcepTest data

before discussion

<table>
<thead>
<tr>
<th>answer</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>count</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

just guessing
not quite sure
pretty sure
Research: providing the basis for change

ConcepTest data

after discussion

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
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<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>80</td>
</tr>
<tr>
<td>C</td>
<td>20</td>
</tr>
</tbody>
</table>

- just guessing
- not quite sure
- pretty sure
ConcepTest data

Research: providing the basis for change
Research: providing the basis for change

ConcepTest data

% correct answers

before discussion

after discussion
Research: providing the basis for change

ConcepTest data

% correct answers

before discussion

after discussion

% correct answers
Research: providing the basis for change

ConcepTest data

A scatter plot showing the percentage of correct answers before and after discussion. The x-axis represents the percentage of correct answers before discussion, and the y-axis represents the percentage of correct answers after discussion. A shaded area indicates a significant increase in correct answers post-discussion.
who benefits from the ConcepTests?
Research: providing the basis for change

who benefits from the ConcepTests?

[Scatter plot showing the relationship between individual CT score (%) and final grade (%). The plot displays a positive correlation between the two variables.]
Research: providing the basis for change

even the best students are challenged
Research: providing the basis for change

even the best students are challenged
On a Saturday afternoon, you pull into a parking lot with unme-tered spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.
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How long do you have to wait before someone frees up a space?
On a Saturday afternoon, you pull into a parking lot with unme-tered spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

How long do you have to wait before someone frees up a space?

Requires:

Assumptions
Developing a model
Applying that model
On a Saturday afternoon, you pull into a parking lot with unme-tered spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces. **On average people shop for 2 hours.**

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Assuming people leave at regularly-spaced intervals, how long do you have to wait before someone frees up a space?
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Assuming people leave at regularly-spaced intervals, how long do you have to wait before someone frees up a space?

Requires:

Applying a (new) model
On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area, where people are known to shop, on average, for 2 hours. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

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How long do you have to wait before someone frees up a space?

$$t_{\text{wait}} = \frac{T_{\text{shop}}}{N_{\text{spaces}}}$$
Problems with problems

On a Saturday afternoon, you pull into a parking lot with unme-tered spaces near a shopping area, where people are know to shop, on average, for 2 hours. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

How long do you have to wait before someone frees up a space?

Requires:

Using a calculator

\[ t_{\text{wait}} = \frac{T_{\text{shop}}}{N_{\text{spaces}}} \]
Resources

Books with ConcepTests:

- Physics (Prentice Hall)
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- Physics (Prentice Hall)
- Chemistry (Prentice Hall)
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- Physics (Prentice Hall)
- Chemistry (Prentice Hall)
- Astronomy (Prentice Hall)
Resources

Books with ConcepTests:

• Physics (Prentice Hall)
• Chemistry (Prentice Hall)
• Astronomy (Prentice Hall)
• Calculus (Wiley)
Information on Just-in-Time-Teaching:

- Prentice Hall book
- http://www.jitt.org
Videos:

• Thinking together
• From questions to concepts

http://www.ankerpub.com
Course management:

http://deas.harvard.edu/ilt
Barriers to reform

Challenges:

• skepticism

• growing pains

• limited circle of influence
Barriers to reform

Two things to watch out for
After changing, things might get worse before they get better!
Better understanding leads to more — not fewer — questions!

(must recognize confusion as step towards understanding)
Barriers to reform

Things to do:

• take data

• motivate students

• be prepared for initial adjustments
Funding:

National Science Foundation

for a copy of this presentation:

http://mazur-www.harvard.edu