Educating in Bulk: The Introductory Physics Course Revisions at Illinois
(Mats Selen, UIUC Department of Physics)

- What we teach & who we teach it to.
- How it used to work (badly).
- How we do it now (and how we know it works).
  - “Infrastructure” & “Faculty Buy-In”
  - Feedback
- Some key aspects of our approach.
  - WEB-centric organization (infrastructure).
  - Peer instruction in Discussion & Lab sections (TA training).
  - ACTs & Preflights in Lecture
  - Homework & Interactive Examples
  - Exams
- Concluding thoughts about course revisions like ours
- Physics 100 (optional)
Overview of the UICU calculus-based introductory physics sequence

- Physics 111 (4 hrs, mechanics)
- Physics 112 (4 hrs, E&M)
- Physics 113 (2 hrs, thermo/stat-mech)
- Physics 114 (2 hrs, waves/quantum)

- Total enrollment of about 3500
- Mostly Engineering & Physics students

Most freshmen start here

In Phase
Out of Phase

Spring

Fall

Summer

900 in 111
350 in 112
550 in 113/114

450 in 111
750 in 112
450 in 113/114
Overview of the UICU algebra-based introductory physics sequence

- Physics 101 (5 hrs, mechanics, heat, fluids, waves)
- Physics 102 (5 hrs, E&M, Light, Atoms, Relativity)

- Total enrollment of about 1100
- Mostly pre-med & life-science students
How it used to work:

- **Tradition, Tradition, Tradition**
  - Lecturer “owns” the course and is free to “reinvent the flat tire” every semester.
  - Discussion TAs pretty much on their own.
  - Labs intellectually disconnected from rest of course.
  - Typically only quantitative problems on exams.

- **RESULTS: NOBODY IS HAPPY!!**
  - Lecturer dislikes it since it’s a monster teaching assignment.
  - Students dislike it because they see the lecturer dislikes it and because the organization is often “uneven” at best.
How we do it now:

- Integrate all aspects of a course using active learning methods in a team teaching environment.

  ➔ Typically 3 faculty share the load:
    ➔ Lecturer (lectures, ACTs, preflights, exams).
    ➔ Discussion Director (TA training, quizzes, exams).
    ➔ Lab Director (TA training, web homework, exams).

  ➔ Course administration is shared responsibility:
    ➔ Faculty meet at least once a week with each other and with their TA’s to plan the campaign.
    ➔ Overall co-ordination is very tight (web helps this).
    ➔ Everybody works on creating exams.
Course material changes adiabatically:

» Recycled & tuned from semester to semester.
» People don’t need to re-invent the whole stew, but can focus on the spices!

Advantages of this approach:

» Existing (evolving) infrastructure lowers the bar for participation.
  » This is now seen as a reasonable teaching load.
  » Most of our new junior faculty start teaching in these courses (i.e. not a heavy assignment).

» Pain & Gain are shared
  » No burnout & No heroes.
  » Makes it possible to keep quality high and material consistent even though instructors are changing.
Feedback
(are things better now?)

**THE OLD**

Student Attitudes Towards Physics 102 (fall99)

![Chart showing student attitudes before and after course](chart1)

THE OLD
Spring 95
Total Physics TAs = 77
# “Excellent” = 15
19 ± 5 %

**THE NEW**

Student Attitudes Towards Physics 101 (fall99)

![Chart showing student attitudes before and after course](chart2)

THE NEW
Spring 01
Total Physics TAs = 75
# “Excellent” = 58
77 ± 6 %
Details of some key components:

- WEB-centric organization
- Peer instruction in Discussion & Lab sections
- ACTs & Preflights in Lecture
- Homework & Interactive Examples
- Exams
WEB-centric organization

- **All** course materials available on-line.
  - Lectures, discussion & lab materials, exams...
  - Makes our job easier (copy spring01 → fall01).

- All students do several on-line assignments every week:
  - Homework, Interactive Examples, Quizzes (more on this).
  - Preflights for lectures, labs & discussion (more on this).
  - Exam preparation & exam results (more on this).
  - All grades & progress throughout the semester
    - Students know in advance what everything is worth and the final thresholds for A,B,C,D,F etc
Details of some key components:

WEB-centric organization

Peer instruction in Discussion & Lab sections

ACTs & Preflights in Lecture

Homework & Interactive Examples

Exams
Discussion Sections

- Key Idea: Collaborative Learning
  - Students work in groups of 4 on problems prepared by the senior staff. TAs act as facilitators, not lecturers.
  - TA preparation very important (extensive training program).
    » Orientation, Weekly Meetings, Mentor TAs, Observation
  - Content of prepared materials very important
Engage the students in the learning process and promote mastery of concepts by manipulation of experimental apparatus.

Prelab assignments; Lab reports finished within class period.
Details of some key components:

WEB-centric organization

Peer instruction in Discussion & Lab sections

ACTs & Preflights in Lecture

Homework & Interactive Examples

Exams
Active Learning in Lecture (ACTs): What's the big idea?

- Break the lecture into 10-15 minute segments (attention span).

- Lecture segments separated by 3-5 minute Active Learning Segments (ACTs).
  - Students work in groups of 3-4 on a conceptual problem posed by the lecturer.
  - Lecturer and (several TA's) wander around the room asking leading questions.
    - Helps the students figure out problem
    - Helps the lecturer understand the students misconceptions.
  - Students “Vote” on the correct answer (in groups)
  - Lecturer presents solution and discusses perceived misconceptions.
  - Lecturer does appropriate demo (if possible).
Example: Lecture 5, Act 4
Force and acceleration

- A block weighing 4 lbs is hung from a rope attached to a spring scale. When the other side of the scale is attached to a wall it reads 4 lbs. What will the scale read when the other side is instead attached to another block weighing 4 lbs?

**Let's Vote!**

(a) 0 lbs.  
(b) 4 lbs.  
(c) 8 lbs.

*Most students get it wrong ... fuel for discussion*
ACTs are great, what are drawbacks & limitations?

- Out of class preparation time.
  - Questions need to be carefully thought out:
    - Match lecture material
    - Reveal students misconceptions
    - Grab their attention

- In class time adds up too...
  - You will not be able to cover quite as much material in the same amount of time.
  - One of the reasons we went to 75 minute lectures

ACT's are great during lecture, but do nothing to prepare students for the lecture...
Pre-Flights!!

• Students are asked to answer a set of conceptual questions (on the Web) prior to every lecture (and discussion, and lab).

• The main structure is:
  ➔ Students read about material in text.
  ➔ Students answer pre-flight questions on material prior to lecture.
    » Physics 101 PF’s due at 6am, lecture starts at 1pm.
    » Graded on participation, not correctness.
  ➔ Instructor uses pre-flight responses to guide lecture preparation.
    » Stress difficult material
  ➔ Pre-flights are reviewed during lecture, often presented again as ACTs, and often capped off with a demo.

• With careful preparation, the pre-flights can form the “backbone” of the lecture.
What the students see on the web:

Lecture 2 Preflight

(6 questions)

If you change any of your answers, be sure to click on Store My Answers at the bottom of this page before you leave. The deadline for storing your answers is 0600 on 01/24/2001.

1) If the average velocity of a car during a trip along a straight road is positive, is it possible for the instantaneous velocity at some time during the trip to be negative?
   - Yes   - No

2) Briefly justify your answer:

3) If the velocity of some object is not zero, can its acceleration ever be zero?
   - Yes   - No

4) Briefly justify your answer:

5) Is it possible for an object to have a positive velocity at the same time as it has a negative acceleration?
   - Yes   - No

6) Briefly justify your answer:

What I typed in a simple text file:

title "Lecture 2 Preflight";

question "If the average velocity of a car during a trip along a straight road is positive, is it possible for the instantaneous velocity at some time during the trip to be negative?"
   - right "Yes";
   - wrong "No";
   - radio;  
question "Briefly justify your answer:";
   - textarea;

question "If the velocity of some object is not zero, can its acceleration ever be zero?"
   - right "Yes";
   - wrong "No";
   - radio;
question "Briefly justify your answer:";
   - textarea;

question "Is it possible for an object to have a positive velocity at the same time as it has a negative acceleration?"
   - right "Yes";
   - wrong "No";
   - radio;
question "Briefly justify your answer:";
   - textarea;

The instructors interface to the student responses (also on web):

phys101/spring00 lecture preflight responses

Pick a lecture preflight from this list: G2

Mark the number(s) of the answer(s) you want displayed: [optional]
If you don’t mark any, the answers to all of the questions will be displayed.

A1 (mupton)
A2 (e-potter)
C1 (prank)
C2 (e-potter)
E2 (mupton)

Pick section(s): G1 (e-potter) [required]

Choose the students to include: ✔ those who responded  □ those who did not respond

Set filter if needed. (samples)
Include only students for whom:

Specify the student identifier(s) to be displayed: □ name and netid  □ section  □ special id

Then click on this button: Responses

Or click on this one: Percentages
If the average velocity of a car during a trip along a straight road is positive, is it possible for the instantaneous velocity at some time during the trip to be negative?

1 - Yes  correct
2 - No

As long as the net distance traveled over the given time was positive, the average velocity will be positive—regardless of whether the car went in reverse at any point during that time.

I could have forgotten something at home and had to turn around, but eventually I reached my destination away from my starting pt.

Velocity cannot be negative in reality.
Two identical boxes, each having a weight $W$, are tied to the ends of a string hung over a pulley (see picture). What is the tension $T$ in the string? [see text 4.10]

1. $T=0$
2. $T=W$  \[\text{correct}\]
3. $T=2W$
Two identical boxes, each having a weight $W$, are tied to the ends of a string hung over a pulley (see picture). What is the tension $T$ in the string? [see text 4.10]

1. $T=0$
2. $T=W$
3. $T=2W$

Due to Newton's second and third laws, the rope itself is massless, so any force transmitted across it is done so without the diminishing of any magnitude. As each box has an equal weight, the tension $T$ must be zero, as each box's force cancels the other's out.

The force applied to the rope is transmitted to the other side. This example would be just like a person hoisting up a box, pulling on the rope with a force of $W$. In this case, the tension would just be $W$.

The string has the tension of two weights.
Shown is a yummy doughnut. Where would you expect the center of mass of this breakfast of champions to be located? (Explain your reasoning Homer).

In the center. Assuming a perfectly symmetrical donut, all the mass is equidistant from the center. Until someone takes a bite. (Doh)

CORRECT

you're not getting my answer unless i get sprinkles.....suckers ! unfortunately, i think the center of mass of this perfectly symmetrical donut would be the center of the donut which does not seem to exist; so, i'll just say homer ate it.

INCORRECT

I think it would be in a the middle of the dough in a circular pattern. Kind of like the onion in an onion ring. UMMMMM..... Onion rings!!!!
Details of some key components:

WEB-centric organization

Peer instruction in Discussion & Lab sections

ACTs & Preflights in Lecture

Homework & Interactive Examples

Exams
Web-based Homework:

Three Blocks

Blocks of mass 3, 6, and 9 kg are lined up from left to right in that order on a frictionless surface so each block is touching the next one. A rightward-pointing force of magnitude 12 N is applied to the left-most block. What is the magnitude of the force that the middle block exerts on the rightmost one?

\[ F_{\text{right, middle}} = \] N  

What is the magnitude of the force that the leftmost block exerts on the middle one?

\[ F_{\text{middle, left}} = \] N

Suppose now that the left-right order of the blocks is reversed. Now find the magnitude of the force that the leftmost block exerts on the middle one?

\[ F'_{\text{middle, left}} = \] N

Students are (usually) told whether their answer is correct. Students can try as many times as they like before deadline.
A drawback for some students: Limited help available...

### Three Blocks

Blocks of mass 3, 6, and 9 kg are lined up from left to right in that order on a frictionless surface so each block is touching the next one. A rightward-pointing force of magnitude 12 N is applied to the left-most block. What is the magnitude of the force that the middle block exerts on the rightmost one?

\[ F_{\text{right, middle}} = \text{N} \]

**HELP:** Draw a Free-Body Diagram to find the forces on the rightmost block. Then apply \( F = ma \).

**HELP:** What is acceleration of the rightmost block? Is it the same as the other blocks? How can you determine the acceleration of the system of three blocks?

What is the magnitude of the force that the leftmost block exerts on the middle one?

\[ F_{\text{middle, left}} = \text{N} \]

**HELP:** Draw a Free-Body Diagram to find the forces on the middle block. Remember Newton's Third Law. Then apply \( F = ma \). You should already know the acceleration from part (a).

**HELP:** Newton's Third Law says that the force exerted on the middle block by the right block is equal in magnitude and opposite in direction to the force exerted on the right block by the middle block.

Suppose now that the left-right order of the blocks is reversed. Now find the magnitude of the force that the leftmost block exerts on the middle one?

\[ F'_{\text{middle, left}} = \text{N} \]
Interactive Examples (Socratic Dialogue)

Block on Incline

A block is positioned on an incline of angle 30 degrees a distance $d = 10$ meters up the incline as shown in the picture.

Start by asking a numeric question (usually multi-step)

If the block is assumed initially at rest, how long will it take to reach the bottom of the incline?

$t =$ s

when students click in “Help”...
HELP

This problem is a little more difficult. It combines two different class topics. If we can find an acceleration for the block we can compute the time it takes to slide down using techniques from the last couple of weeks.

Now if we were to apply Newton's second law to our problem we could compute an acceleration. So as with this type of problem we again should turn to Tiplers five steps for solving mechanics problems (on pg. 96 of text):

1. Draw a diagram
2. Isolate the object and draw a free-body diagram with the forces acting on that object
3. Choose a coordinate system and apply Newton's second law \( \sum F = ma \) in component form
4. Solve for any unknowns
5. Check to see if answer is reasonable

So again go ahead and try these steps and see how far you can get. If you need additional help click below.

Alright, so we'll assume you have already drawn a picture. We'll also assume that our object of interest here is the block. So our next step is to figure out which forces act on the block and construct our Free-Body-Diagram (FBD).

So first of all how many forces are acting on the block (Remember the incline is said to be frictionless)?

- One
- Two
- Four

..."Help" results in a discussion followed by some multiple-choice questions that lead them toward the answer...
So first of all how many forces are acting on the block (Remember the incline is said to be frictionless)?

- One
- Two
- Four

Good, we have two forces:

1. The force of gravity pulling down on the block, we'll call it W
2. The force of the incline pushing up on the block, we'll call it N the normal force.

You're Free-Body-Diagram should look similar to this:

![Diagram with forces W and N]

This dialogue can take several steps...

You will find that problems like these (i.e. Incline problems) tend to be similar. A very important aspect of Incline problems is choosing a correct coordinate system. When doing this you must keep in mind your final goal, in our case you want to get the acceleration of the block parallel to the incline.

Think about what coordinate system you think would be best to use.

CLICK Enter TO CONTINUE.
Correct, With this system you can apply Newton's second equation in the x-direction and solve for the acceleration down the incline, which is what you want. Remember that a good rule is to choose one of your axes to be parallel to the direction that the object is accelerating. With this choice of axes this is the x direction.

Our next step is to apply Newton's second law to our x-direction and solve for the acceleration. After that we use constant acceleration equations from the last few weeks to compute the time it takes the block to slide down the incline.

Now, what is the acceleration down the incline?

\[ a_{\text{incline}} = \quad \text{m/s}^2 \quad \text{Enter} \quad \text{Help} \]

Eventually they get another (simpler) numeric question whose answer is needed to solve the primary numeric question.
Clicking on “Help” again results in a similar dialogue as the first time, although one level “deeper”.

- Problems can be 4-5 levels deep
- Eventually they get enough info to solve the problem.

Coordinate System A

we have to apply Newton's second law to the x-direction so we can find the acceleration in our x-direction, which is the acceleration down the incline.

So our first step must be to figure out which forces act on the block in our x-direction.

The normal force is completely in the y-direction, so we need not worry about it. However there will be a component of the block's weight W in the x-direction. We must use trigonometry to compute what it is. Let's do that now.
Once they get right the answer

They get a recap

And some follow-up questions

If the block is assumed initially at rest, how long will it take to reach the bottom of the incline?

\[ t = \frac{2}{3} \times 2 \quad \text{OK} \]

Good job! You have solved the problem - let's summarize what you did:

- Determine what concepts apply to this problem.
- Draw a Free-Body Diagram and choose your axes.
- Set up an equation (or system of equations) and solve for acceleration.
- Use the acceleration to find the time it takes the block to fall.

FOLLOW-UP QUESTION 1 (not for credit):

If the angle of the incline were decreased:

\[ \text{OK} \quad \text{The time taken would increase.} \]
\[ \text{C} \quad \text{The time taken would stay the same.} \]
\[ \text{C} \quad \text{The time taken would decrease.} \]

Good, if the angle were to decrease the acceleration would decrease. Therefore, it would take longer to go down the incline.

FOLLOW-UP QUESTION 2 (not for credit):

If the mass of the block were to increase:

\[ \text{C} \quad \text{The time taken would increase.} \]
\[ \text{OK} \quad \text{The time taken would stay the same.} \]
\[ \text{C} \quad \text{The time taken would decrease.} \]

Good, the acceleration is not changed by the mass. In our Newton's second equation \( \Sigma F = ma \) we get

\[ mg \sin(\theta) = ma \]

so the mass cancels out. If the Acceleration is the same, the time it takes to slide down must also be the same.
Details of some key components:

WEB-centric organization

Peer instruction in Discussion & Lab sections

ACTs & Preflights in Lecture

Homework & Interactive Examples

Exams
Exams

- Three mid-terms & one comprehensive final (typically).
- Combined worth ~ 60% of final grade.

- **All multiple choice (machine graded).**

  ➤ **PROS:**
  » Uniform & Fair.
  » Useful for tracking changes, education research...
  » WEB interface possible for practice (before exam night) and help/explanations (after exam).

  ➤ **CONS:**
  » Harder to give partial credit...
  » But not impossible: we have a scheme!
14. A ball of mass \( M \) is suspended vertically from the end of a string. The other end of the string is attached to the ceiling of an elevator, as shown in the figure. The elevator is initially moving downward at constant speed. Just before reaching the bottom floor, the elevator slows down. As it is slowing down, the tension in the string will be

a. greater than \( Mg \)
b. equal to \( Mg \)
c. less than \( Mg \)

The following two problems relate to the same physical situation.

15. Block A of mass 2 kg and block B of mass 4 kg are attached to each other by a string. The two blocks are sitting on a horizontal frictionless surface. Another string is attached to block B and the whole system is pulled to the right so that both blocks accelerate together, as shown in the figure. If the tension \( T \) is 15 N, as shown in the figure, what is the tension \( T_1 \) in the string connecting the two blocks?

a. 1 N
b. 3 N
c. 5 N
d. 12 N
e. 15 N

16. In the preceding problem, suppose the order of the two blocks is reversed so that block A is in front and B is in back, with the same tension \( T = 15 \) N, as shown in the figure. Compared to the preceding problem, the tension \( T_1 \) is now?

a. greater
b. less
c. the same
Analysis of exam “data” is very interesting (and useful for education research).

More sophisticated analyses can be used to rate the effectiveness of various approaches to designing exam questions.
Instant exam feedback is possible:

- The minute they leave the exam, students can go on the web, enter their answers into a web version of the exam they just took, and see what their raw score is. They really like this!

**QUESTION 25**

Consider two identical satellites, each in circular orbit around the earth but at different distances from the center of the earth. Which satellite has the higher speed?

- (a) the one further from the center of the earth
- (b) the one closer to the center of the earth
- (c) they both have the same speed

- After the exam has been graded (next day) students can find detailed statistics on each problem on the web.
Concluding Thoughts

- Strong departmental support is needed to pull this off:
  - Vision, leadership, money (faculty release time).

- Developing a sustainable & evolving infrastructure is the first part of the battle.
  - We are eager to give away any/all of the materials & tools we have developed, and (of course) hope to get new ideas back.

- Getting faculty to “buy in” is the second necessary ingredient.
  - Not everyone likes this approach.

- At UIUC, most people have bought in to the “new” way.
  - 42 of ~70 faculty have taught in these courses since 1995! (wow).
  - “I can do it better all by myself”
Physics 100: Why offer a preparatory course?

- Despite the University of Illinois’ C of E high admission standards, nearly 20% of accepted students are inadequately prepared to pass our introductory mechanics course (i.e. they earn a D or F).
  - The failure rate is even higher for minority groups.
    » As high as 68% for African Americans.

- Many students do not realize that they are poorly prepared.

- We need to identify inadequately prepared students and help them gear up for Physics 111 and beyond.
Student Selection

- Self evaluation quiz is offered in the Fall semester to all freshman in the College of Engineering as well as all students enrolled in physics 111.

- Students receiving a score below a certain cutoff are invited to take Physics 100 (1 credit-hour).
  - Much less than half of identified students choose to participate initially.
    » This should really be a placement exam!

- Physics 100 does not officially start until about 3 weeks into the fall semester.
  - Gives students time to evaluate their situation
  - Many decide to take Physics 100 after doing poorly on the first Physics 111 mid-term exam.

- Typical Physics 100 enrollment ~ 100
The Self Evaluation

- Tests basic math and physics background.

- Students take this (individually) on the web.
  - No time pressure while taking test.
  - They can try the test as many times as they want to (before deadline), although they are not given feedback until after the deadline.

- Consists of 16 multiple choice questions.
  - 8 of these (found the most predictive) are used to arrive at their “score”.

- Students that get less than half right are invited to take Physics 100.
Example Self Evaluation Questions...

Did you take high school physics?

(a) Yes
(b) No
(c) Yes but it was lousy
Example Self Evaluation Questions...

Here we have two vectors \( \bf{V} \) and \( \bf{W} \). The angle between these vectors is \( A \).

1) What is the component of \( \bf{V} \) parallel to \( \bf{W} \) in terms of \( A \) and the magnitudes of \( \bf{V} \) and \( \bf{W} \)?

(a) \( \bf{V} \)
(b) \( \bf{W} \)
(c) \( V \sin(A) \)
(d) \( V \cos(A) \)
(e) \( W \sin(A) \)
(f) \( W \cos(A) \)

(Basic trig)
Self evaluation - Physics 111 correlation:

![Graph showing the correlation between self evaluation score and Physics 111 grade.](image-url)
Class Structure:

- **Weekly cycle:**
  - Textbook reading assignment
  - Web Based Homework (based on reading)
    - Traditional problems.
    - Interactive Examples (IE’s).
    - Unlimited tries before deadline, immediate feedback.
  - Web Based Preflight (JITT)
    - Provides information to instructor prior to discussion section.
    - Graded on participation only
  - Discussion (2-hour capstone)
    - Group problem solving facilitated by instructor
    - Graded on participation

- **Also:**
  - Three web-based quizzes
  - Written (M/C) final exam
Discussion Section:

- Students work in groups on problems designed after examining homework & preflight answers.
  - Purpose is to tie up loose ends.
  - Students should leave understanding everything done during the previous week.
    - i.e. reading, homework, preflights are capped off by discussion.
  - Graded on attendance & participation
Are we helping students...

Can we reduce the failure rate of under-prepared students in Physics 111/112/113/114?
Probably YES (research by Gladding & Shoaf)

![Graph showing self evaluation score vs. Physics 111 grade for different groups of students.](chart.png)
So...are we helping ??

- It seems like we might be, however there is a big caveat: *Physics 100 students are self selected!*

  - Are we getting only those students that were going to do well anyway?

  - We need more data to study this.

  » A real placement test would be very helpful!
Extra Slides
Simple setup on our NT server:
Text (& pictures) for PF 2 in here

Notice: Lots of folks use our web-based grade-book:
Suppose you float a large ice-cube in a glass of water, and that after you place the ice in the glass the level of the water is at the very brim. When the ice melts, the level of the water in the glass will:

1. Go up, causing the water to spill out of the glass.
2. Go down.
3. Stay the same.  \[\text{CORRECT}\]
phys101/spring00 lecture preflight responses

Pick a lecture preflight from this list: [G2]

Mark the number(s) of the answer(s) you want displayed: [optional]
If you don’t mark any, the answers to all of the questions will be displayed.

Pick section(s): G1 [required]

Choose the students to include: those who responded, those who did not respond

Set filter if needed: (samples)
Include only students for whom:

Specify the student identifier(s) to be displayed: name and netid, section, special id

Then click on this button: Responses
Or click on this one: Percentages

Nice Tools: We can “filter” on responses based on other questions!!
Lecture 20, Preflight 2

Which weighs more:
1. A large bathtub filled to the brim with water.
2. A large bathtub filled to the brim with water with a battle-ship floating in it.
3. They will weigh the same. \(\text{CORRECT}\)

Students who got Preflight #1 right.

Tub of water

Students who got Preflight #1 wrong

Tub of water + ship
Some students thoughts on doing ~50 pre-flights

6) How often do you attend the lectures?
   69  50% Always.
   49  36% Regularly.
   10  7% Occasionally.
   4   3% Rarely.
   5   4% Never.

7) How often do you read the text before attending lecture?
   10  7% Always.
   27  20% Regularly.
   50  36% Occasionally.
   26  19% Rarely.
   24  18% Never.

8) Overall how important were the preflights in helping you understand the material?
   11  8% Essential.
   50  37% Very useful.
   55  40% Useful.
   14  10% Not very useful.
   6   4% Useless.

9) Here is a space for any additional comments on the lectures:

   I didn't read the chapters and use the preflights very much in the beginning of the semester but lately I've been using them more and it has been helping very much.

   The lectures were great.

   More lectures needed.

   Pre-flights were a good idea, but often I would forget about them when I had so many other more intense homework to worry about them. I wish there was a way for me to keep them in mind better.

   It was easy to pay attention to Mats during lecture most of the time, but I was always behind on the reading, so I always guessed on the preflights.

   I think this is a great teaching technique (as a future teacher). Even when I didn't have time to read the entire text before coming to lecture, I at least had to flip through the text a couple times.

   I should read. =)
Interactive Example Features:

- Created to develop concept based problem solving skill.
- Quantitative Problems
- Socratic help
  - Conceptual Analysis
  - Strategic Analysis
  - Quantitative Analysis
- Recap
- Follow up questions
Student Logs

- We record all student submissions on IEs: (the conversation)

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phys101/fall00/ielogs/04/car
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This is Research data!

- How much time do students spend on the IEs?
- How well do the students do on their first response to questions?
- How deep into the IE do students go?