Interactive Lecture Demonstrations (ILDs):
A Research-Validated Strategy for Active Learning in Lecture

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New Faculty Workshop
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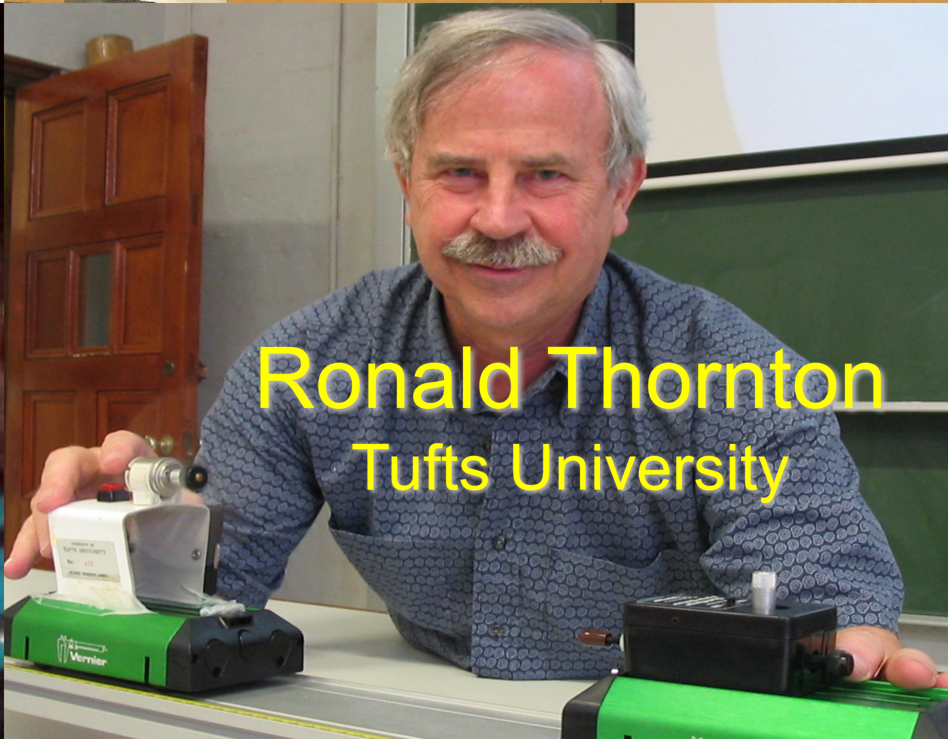
Activity Based Physics

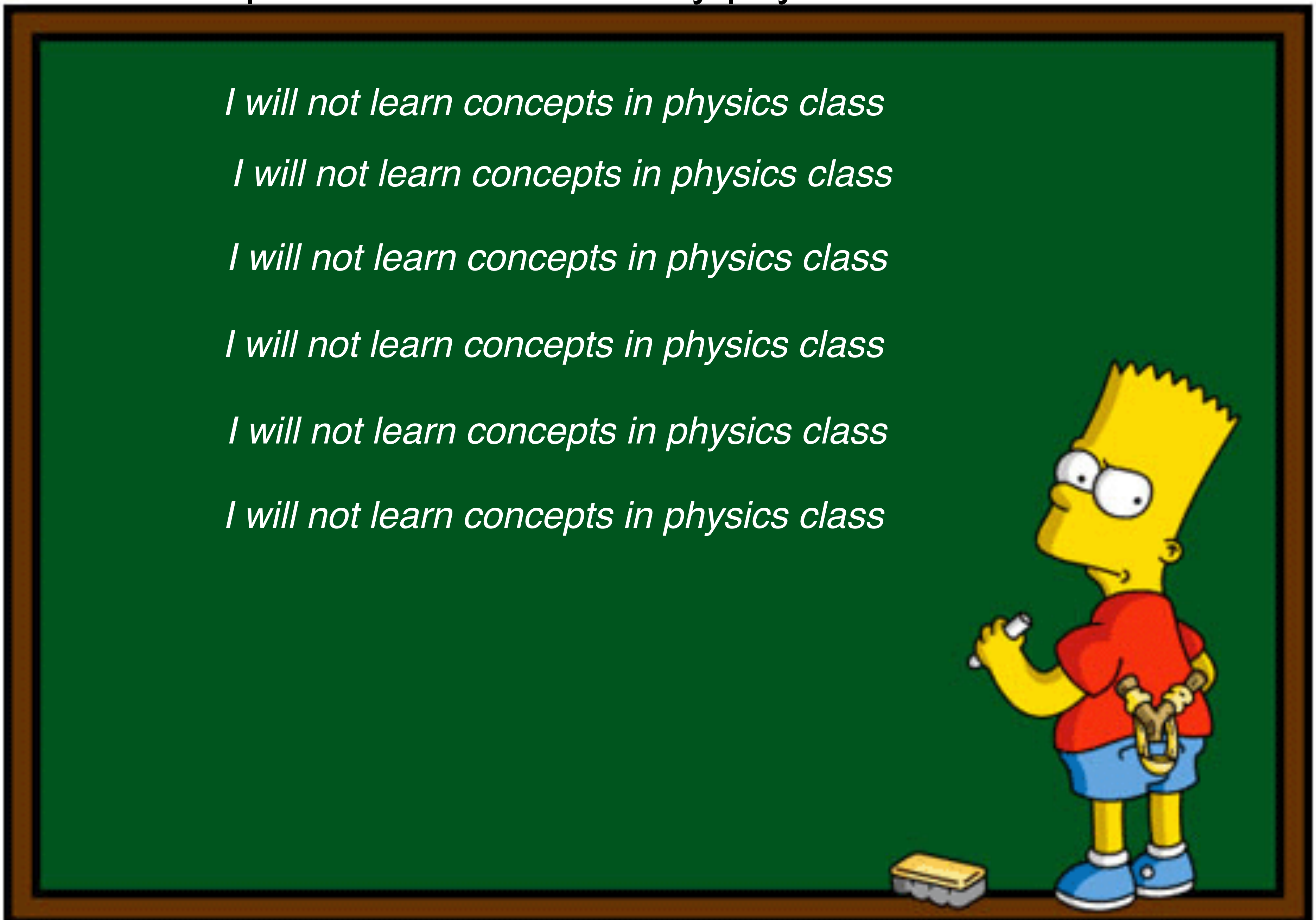
Integrating Physics Education Research with Technology

31 years of physics education research, development and dissemination.

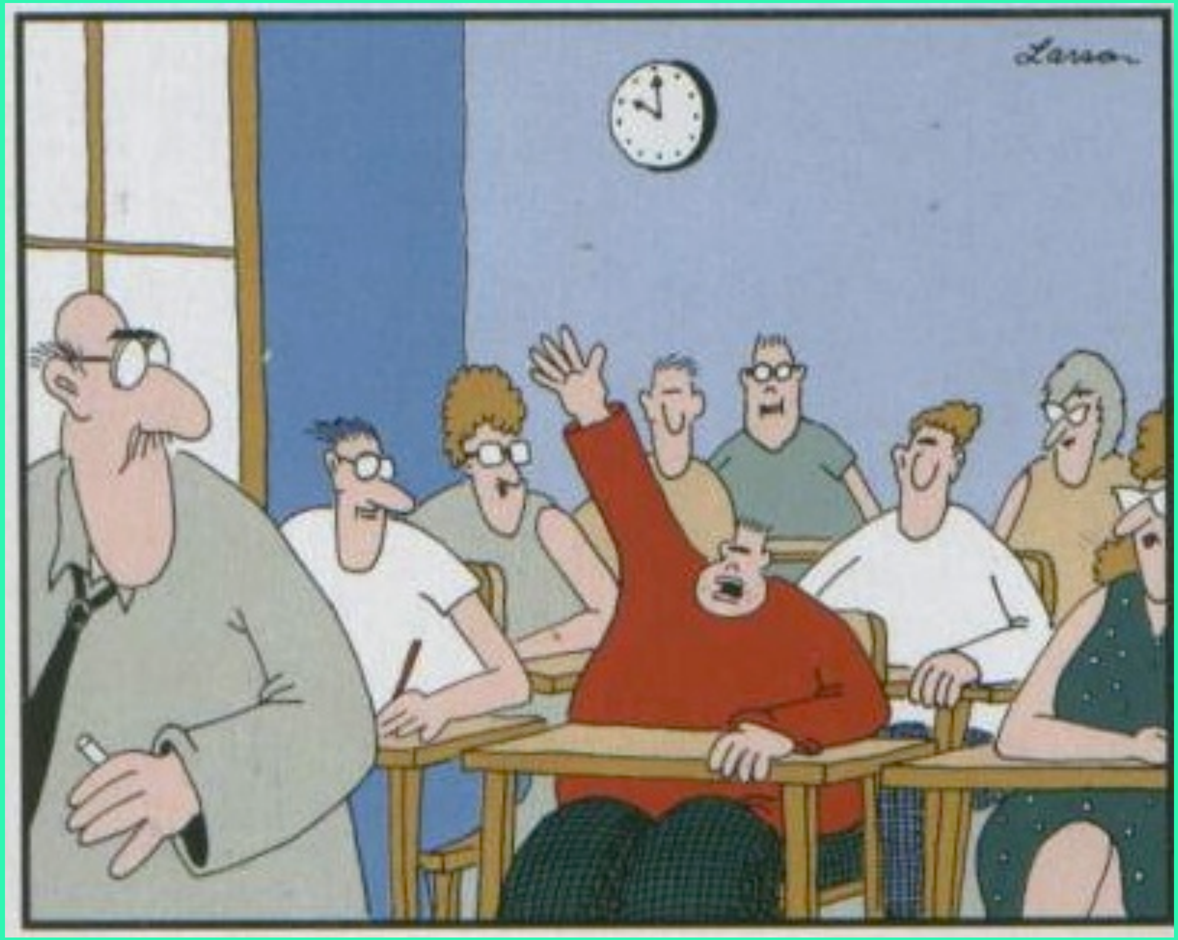
Winner of the *2010 APS Excellence in Physics Education Award*



Students’ experience in introductory physics seems like this:



Most students spend the majority of their time in a lecture, often a large one!



"Prof. Sokoloff, may I be excused? My brain is full!"

Can an active learning environment be created in a large (or small) lecture?

Yes, through the use of
Interactive Lecture Demonstrations (ILDs)

Example of *ILDs*

- You will be our introductory physics class for the next 15 minutes or so.
- We will show demonstrations and ask you to make predictions on Prediction Sheet. (<u>Find in your folders.)</u>
- Note that <u>predictions are never graded</u>, but you will receive 1 point out of the 100 points for this class for participating today.
- We will next ask you to discuss your predictions with your nearest neighbor(s), and see if your small group can reach a consensus on the prediction.
- Finally, we will do the demonstrations with the results displayed. We will ask for volunteers to discuss what you observe with the whole class.

Example of Low-Tech *ILDs* on Image Formation

We will use simple equipment that your department likely owns:

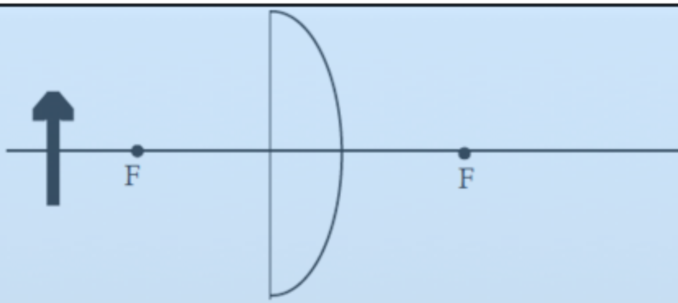
- Large acrylic cylindrical lens (from ray optics demo kit)
- Two small light bulbs as two discrete object point sources of light (instead of a ray box)

Sample Interactive Lecture Demonstration Prediction Sheet for Image Formation

Directions: Write your name at the top of this sheet. This sheet will be collected but not graded. After each experiment is described to you, clearly write your prediction.

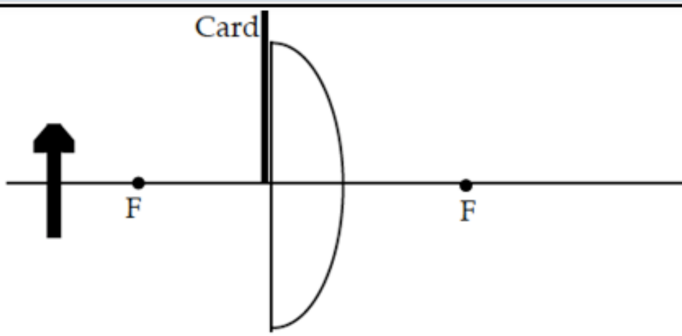
Note: This is a sample of Interactive Lecture Demonstrations prepared for this workshop. They do not represent a complete, coherent sequence. Normally an ILD sequence consists of 6-7 related demonstrations in a single physics topic area.

Image Formation Demonstration 1: You have a converging lens. An object in the shape of an arrow is positioned a distance larger than the focal length to the left of the lens, as shown on the right. Draw several rays from the head of the arrow and several rays from the foot of the arrow to show how the image of the candle is formed by the lens.



Is this a real or a virtual image?

Image Formation Demonstration 2: What will happen to the image if you block the top half of the lens with a card? Answer in words and show what happens on the diagram on the right by making any changes needed in the rays you drew above.



SAMPLE INTERACTIVE LECTURE DEMONSTRATION PREDICTION SHEET FOR IMAGE FORMATION

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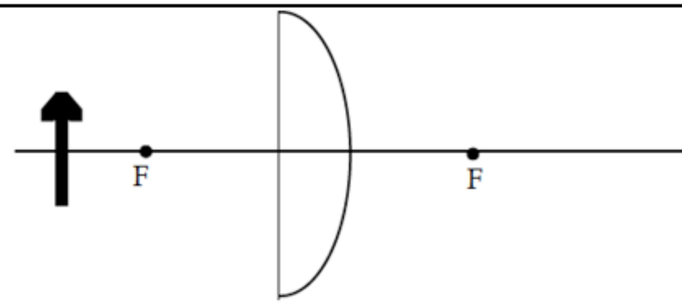

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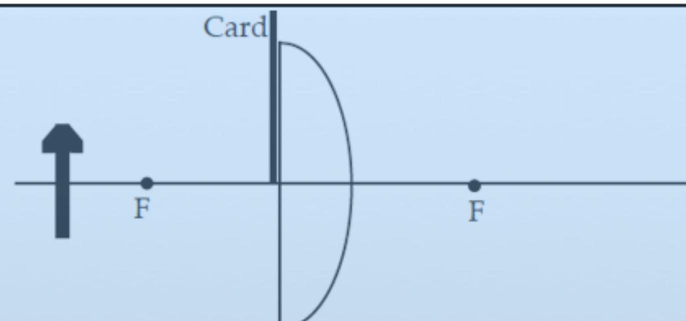
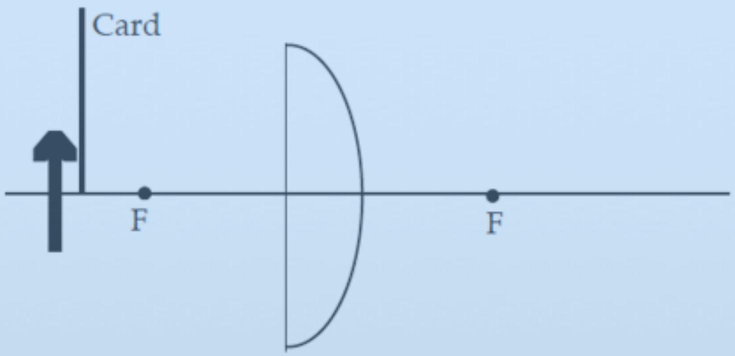


Image Formation Demonstration 3: What will happen to the image if you block the top half of the object with a card? Answer in words and show what happens on the diagram on the right by making any changes needed in the rays you drew above for Demonstration 1.



Why use light bulbs rather than a ray box?

Research evidence shows that students don't understand that

1. An infinite number of rays emanate from each point on an object
2. for a perfect lens, all rays from a single point that are incident on the lens will be focused to a corresponding point on the image

Interactive Lecture Demonstrations (ILDs)

1. Describe the demonstration and do it for the class without results displayed.
2. Ask students to record individual predictions on the Prediction Sheet.
3. Have the class engage in small group discussions.
4. Elicit common student predictions from the whole class.
5. Students record final prediction on the Prediction Sheet (which will be collected).
6. Carry out the demonstration and display the results.
7. Ask a few students to describe the results and discuss them in the context of the demonstration. Students may fill out the Results Sheet.
8. If appropriate, discuss analogous physical situations with different "surface" features..

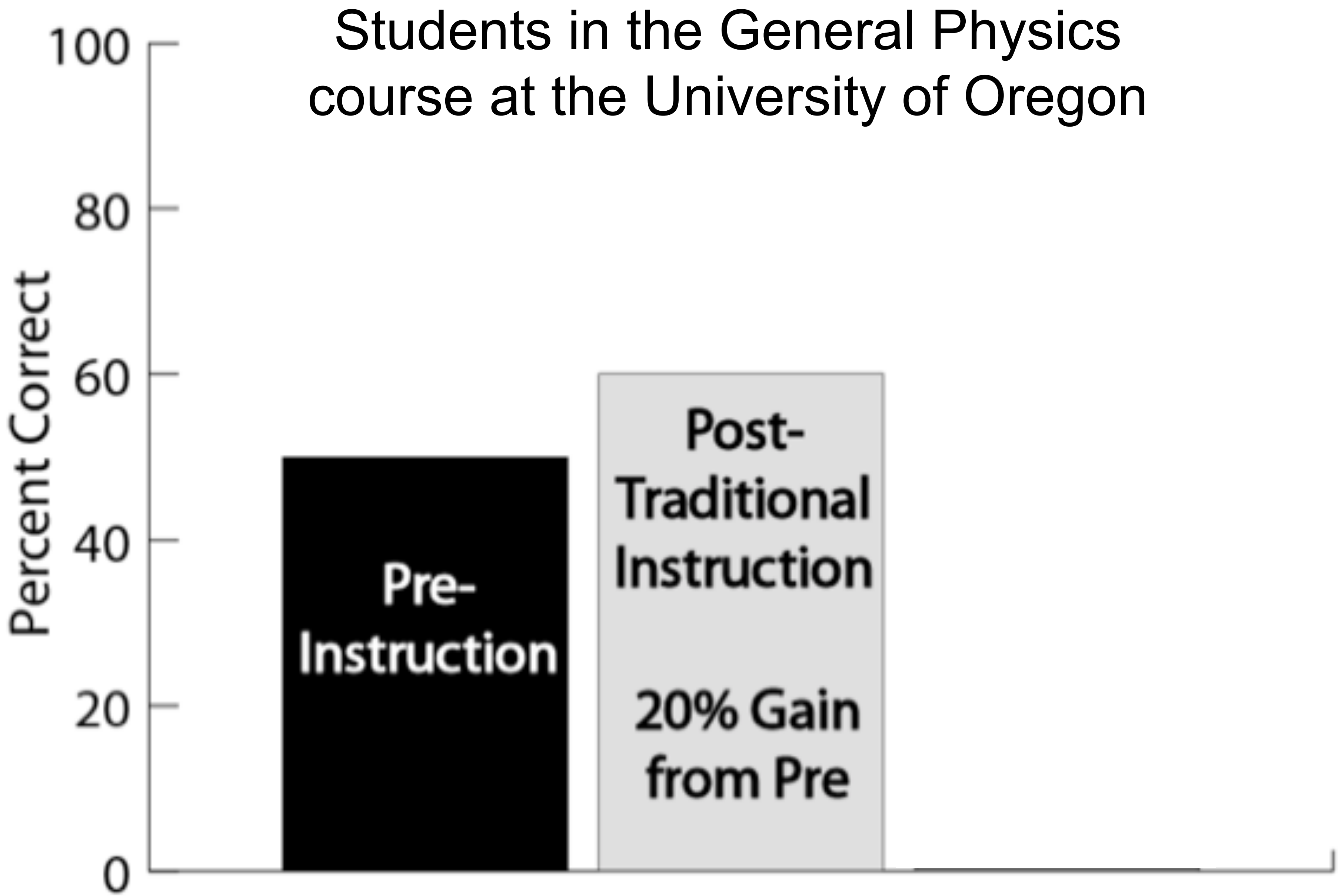
This procedure is followed for each of the short lecture demonstrations in each *ILD* sequence.

Characteristics of the *ILD* Learning Environment that Makes It Effective

- Making predictions requires students to consider their beliefs before making observations of the physical world. The *ILDs* build upon the knowledge that students bring into the course.
- With *ILDs*, the process of prediction, defending the prediction in a small group, and writing down the prediction engages students. They want to know the result of the demonstration.
- The disequilibrium set up by the difference between prediction and observation inspires effective learning opportunities.
- Student knowledge is constructed from observations of the physical world displayed in understandable ways, thus building students' confidence as scientists.

Do students learn concepts from *ILDs*?

Learning gains on the *Light and Optics Conceptual Evaluation (LOCE)*


Students in the General Physics
course at the University of Oregon
100
80
60
40
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Percent Correct
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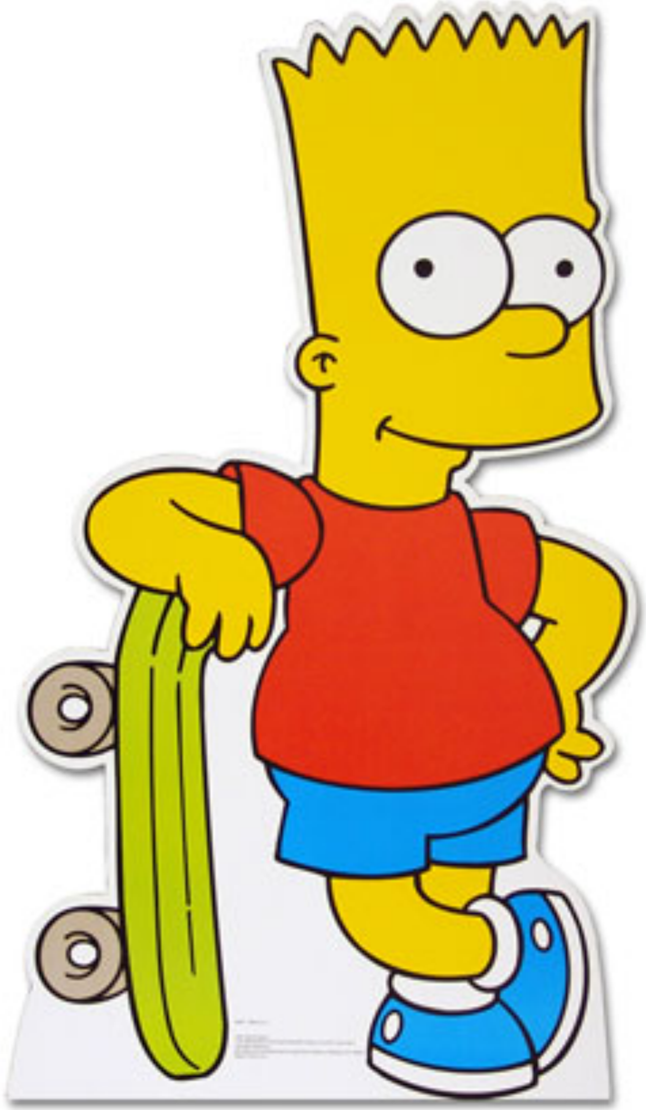
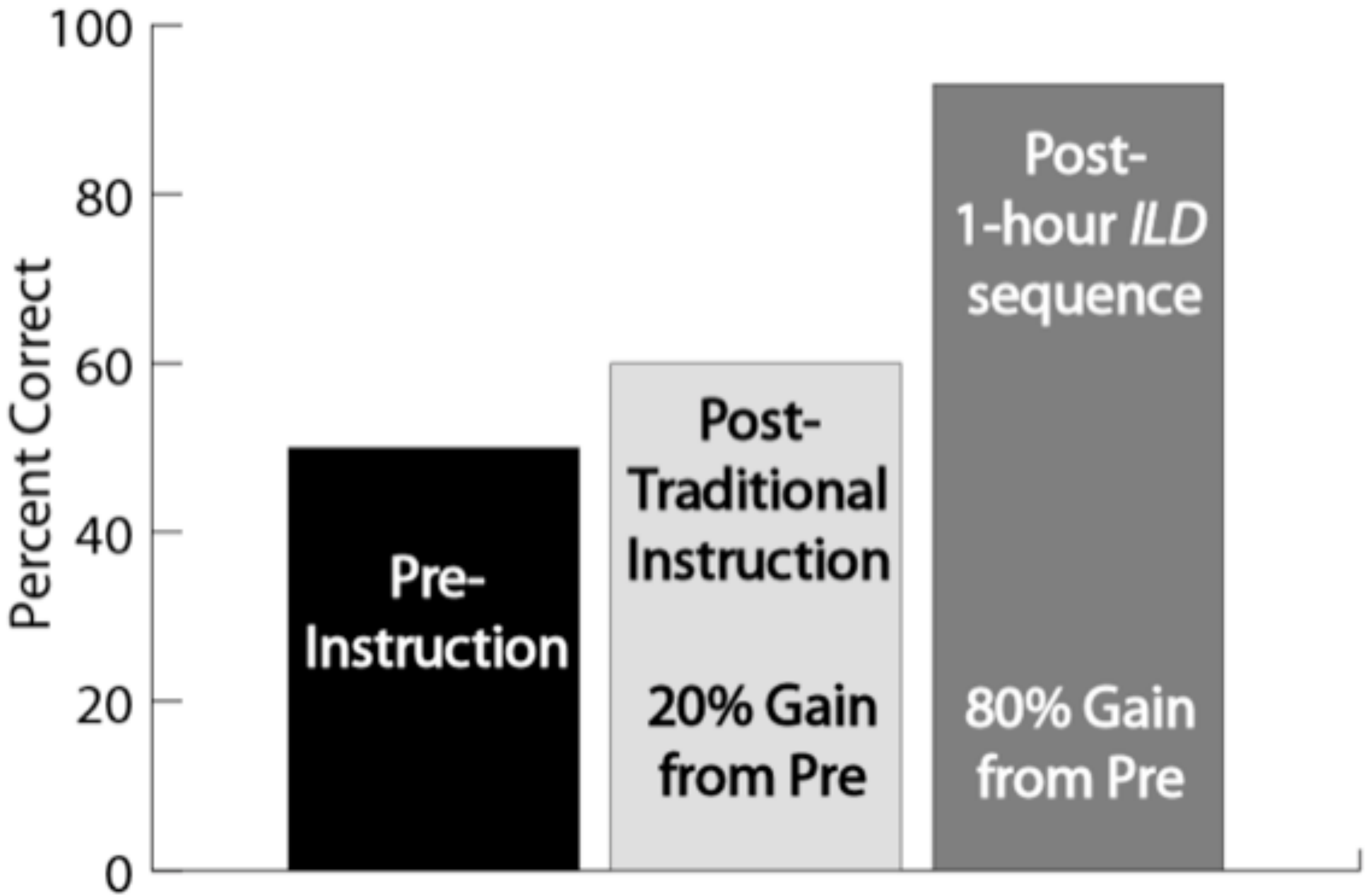
20% Gain
from Pre



“Underachiever . . .

and proud of it, man!”


100
80
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Post-
Traditional
Instruction
20% Gain
from Pre
Post-
1-hour *ILD*
sequence
80% Gain
from Pre

Do Students Learn from Traditional Demonstrations?

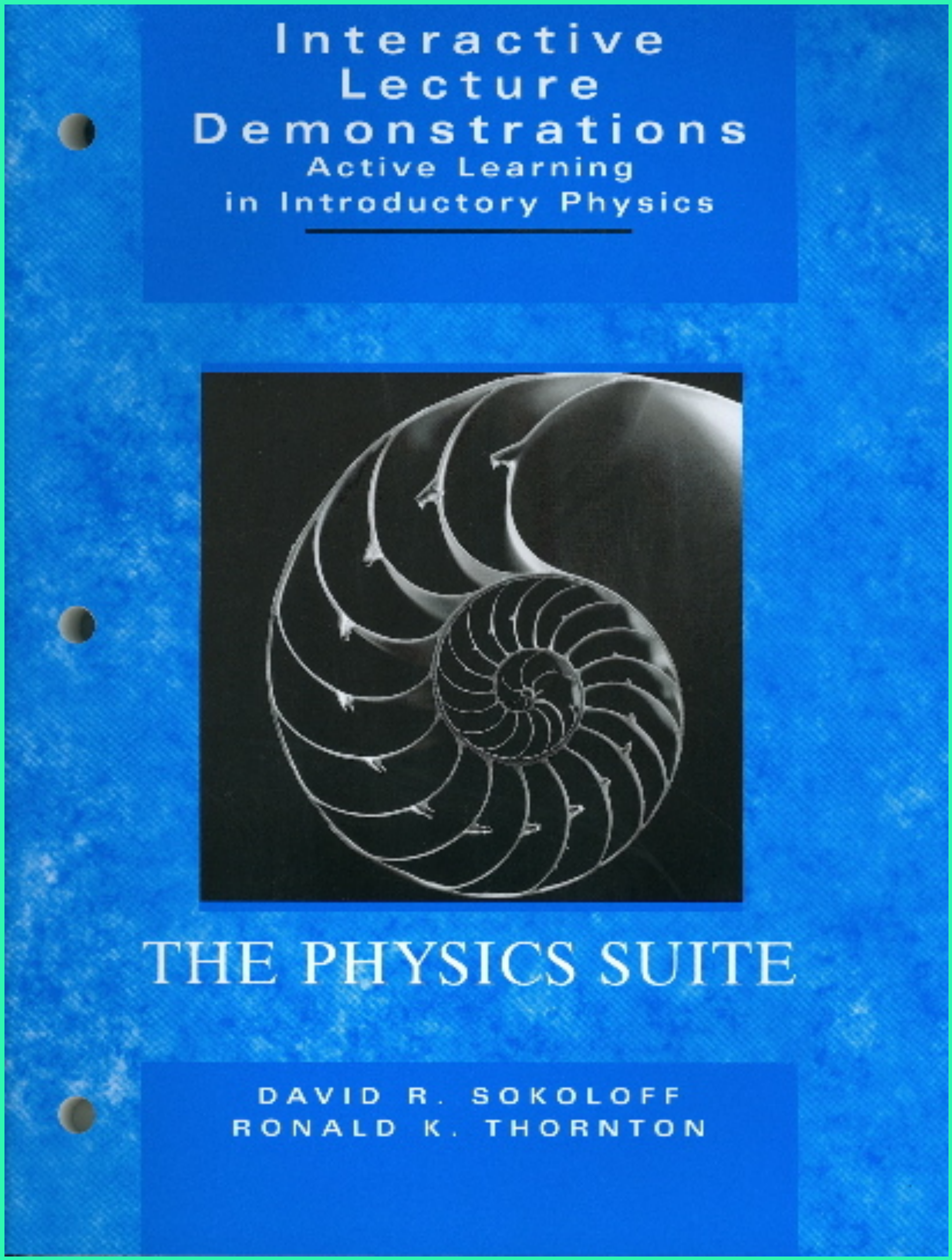
- NO!
- Mazur's PER group at Harvard studied the "shoot the monkey" demonstration presented in traditional and active ways.
- The majority of students who were not asked to make a prediction before the demonstration were not able to describe the outcome of the demonstration correctly, let alone learn from it!
- Many of our most treasured lecture demonstrations are too complex for much learning to result. They could be broken down into smaller pieces, and presented as *ILDs*.

Incorporating *ILDs* into Your Course

- Can be used for introduction of concepts, review or clarification of concepts, or in place of or in conjunction with lab activities.
- *ILDs* on most topics are available in the *Interactive Lecture Demonstrations* book published by Wiley (on your flash drives).
- And you can develop your own *ILDs*, or break down cherished lecture demonstrations into more digestible steps of *ILD* sequences. (<u>But these are not easy to do!!!</u>)

<u>The entire book is on your flash drive</u>. (You can also get a free, paper copy from your Wiley representative.)

Contains everything you need to do *ILDs* on 28 different topics, including student Prediction and Results Sheets.



Some Important Additional Points

On course evaluations, students say *ILDs* are the thing they liked most about the course!

ILDs look easy, but there are some serious potential pitfalls:

- Don’t switch into lecturing mode after the results are displayed—it won’t work. Discussion must come from students!
- Don’t focus on minute details of the results or apparatus—the desired conceptual learning will get lost in these details.

An Activity and Discussion—in Folders

Classroom Scenarios Involving *Interactive Lecture Demonstrations* (*ILDs*)

Directions: Read each of the scenarios described below. Then discuss in your small group whether the instructor's presentation of *ILDs* is appropriate, or if not, how the presentation could be improved.

Scenario 1: The instructor presents the **Image Formation** *ILDs* that you have seen. In Demonstration 1, right after she displays the light from the two light bulbs converging to the two focus points, s/he immediately says to the class "Notice that while the light is focused to these two points, and the image is inverted, because we are using a thick lens, there are multiple reflections within the lens, causing the light to appear to bend in the region between the lens and the focus points. This would not happen if we used a thin lens. It has no bearing on the final result of this demonstration"
NOTES:

Scenario 2: During the step of eliciting predictions from the class for Demonstration 2 of the **Image Formation** *ILDs* before the demonstration is done (*ILD* step 4), the instructor summarizes "Billy predicted incorrectly that half the image will disappear when the top half of the lens is blocked, while Mary predicted, also incorrectly, that the entire image will disappear."
NOTES:

Scenario 3: The instructor designs *ILDs* to replace his favorite classroom demonstration, "shoot the monkey." Here is an excerpt from the Prediction Sheet of the prediction for Demonstration 1.

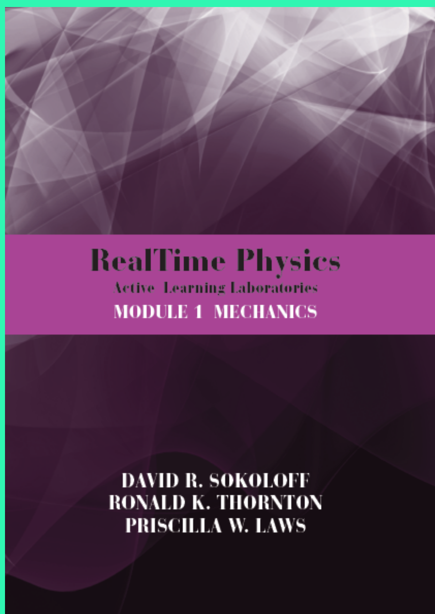
A Few Words About Active Learning in the Introductory Lab

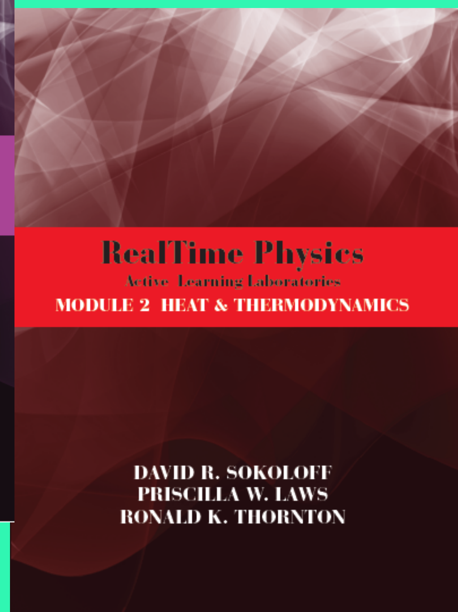
- The focus of this presentation has been on strategies <u>for lecture</u>.
- *RealTime Physics (RTP)* labs promote active learning in the intro. laboratory with real observations of the physical world, often aided by computer-based tools.
- They use the same learning cycle as *ILDs*.

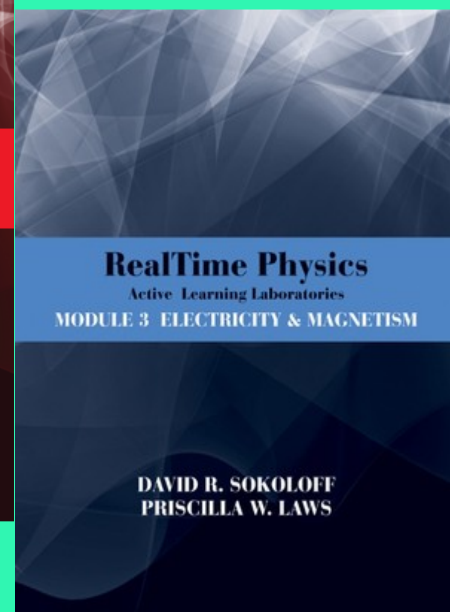
There are four *RTP* modules published by Wiley

Module 1: *Mechanics* ***Module 2:*** *Heat and Thermodynamics*

Module 3: *Electricity and Magnetism* ***Module 4:*** *Light and Optics*







For more information on *RTP* go to www.wiley.com and search *RealTime Physics*.

Use of Technology with *ILDs*

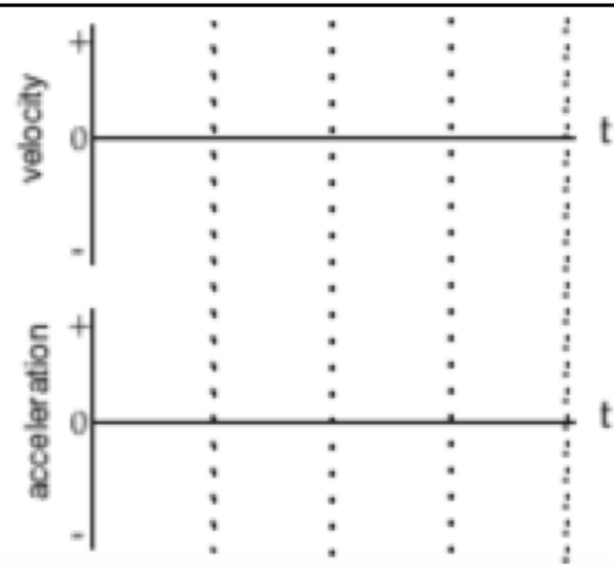
- Many of the *ILDs* in the book make use of computer-based laboratory tools.
- Well-designed tools enable students to observe the physical world with results displayed in understandable ways.
- Some observations cannot be made as effectively in any other way.
- Here’s an example . . .

Mechanics Demonstration 1:

A cart is subjected to a constant force in the direction towards the motion detector. Sketch on the axes on the right your predictions of the velocity and acceleration of the cart after it is given a short push away from the motion detector (and is released). Sketch velocity and acceleration as the cart slows down moving away from the detector, comes *momentarily* to rest and then speeds up moving towards the detector.

Mechanics Demonstration 2:

The origin of the coordinate system is on the floor, and the positive direction is upward. The ball is thrown, moves upward, slowing down, reaches its highest point and falls back downward speeding up as it falls. Sketch on the axes on the right your predictions for the velocity-time and acceleration-time graphs of the ball from the moment just after it is released until the moment just before it is hits the floor.



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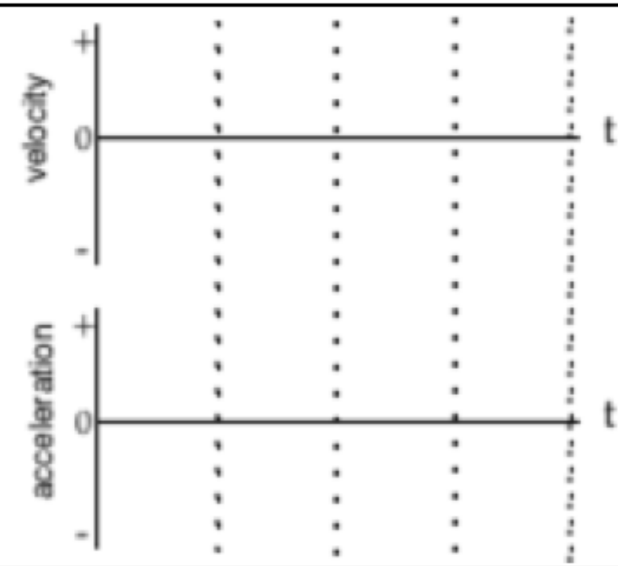

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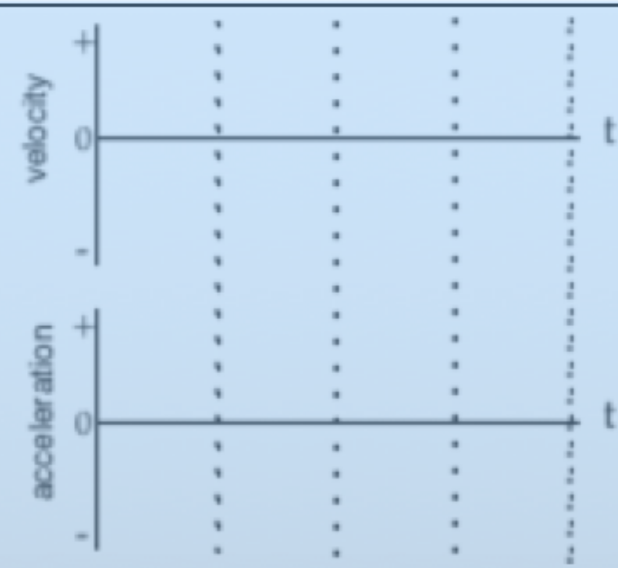
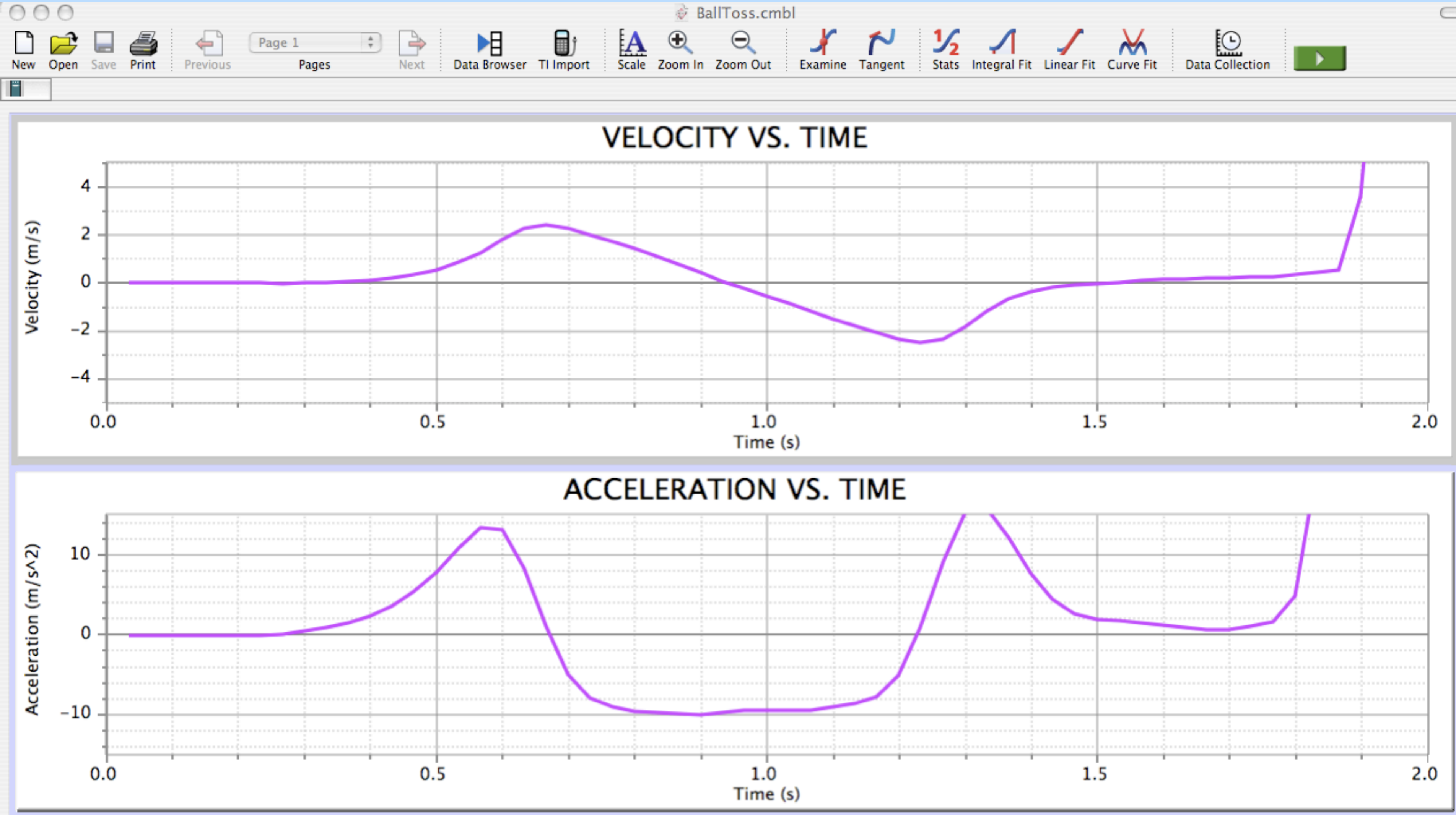



Motion sensor



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TI Import
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Zoom In
Zoom Out
Examine
Tangent
Stats
Integral Fit
Linear Fit
Curve Fit
Data Collection
VELOCITY VS. TIME
Velocity (m/s)
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Time (s)
ACCELERATION VS. TIME
Acceleration (m/s^2)
10
0
−10
0.0
0.5
1.0
1.5
2.0
Time (s)


Engage your students
in the learning process!
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The End