The Physics Education Technology Project: http://phet.colorado.edu

Exploring Easy and Effective Ways to Use PhET's Web-Based Interactive Simulations

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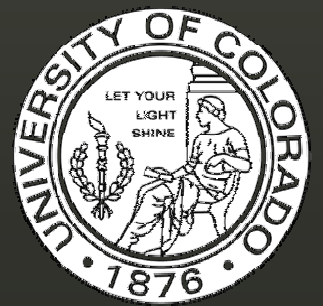


Workshop Goals

1. Become familiar with PhET simulations (~1 hour)
   - What makes PhET sims unique learning tools?
   - How can they be used in class? (*easy, effective)*

2. Plan for sim use in your class (~ 3 hours)
   - Identify useful PhET sims
   - Find useful Activities
   - Develop your own activity (~1.5 hours)

The PhET Group

University Faculty (4), Post-docs (2), Grad Students (3), HS Teachers (1), Computer Programmers (2), Admin (2)

~5-6 full time equivalents

Goal of PhET: To support science education by creating free, effective interactive computer simulations and maintaining a database of lessons.

PhET Funding

NSF

Kavli Foundation

The William and Flora Hewlett Foundation

Hewlett Foundation

University of Colorado

Alfred Nobel

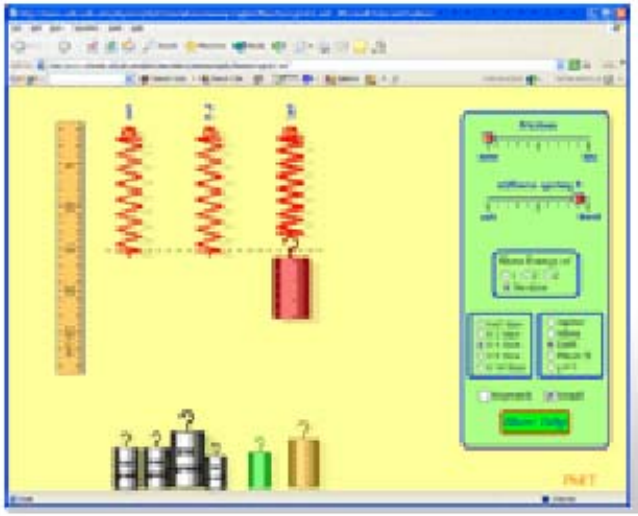
Our promise: PhET sims will *always* be free!

Physics Education Technology Website

PhET

Physics Education Technology
University of Colorado at Boulder

Home | Simulations | Research | About PhET



Interactive Physics Simulations

Fun, interactive simulations of physical phenomena from the Physics Education Technology project at the University of Colorado.

Find out more... »

The William and Flora Hewlett Foundation

The William and Flora Hewlett Foundation

The National Science Foundation

Download PhET

- On Line
- Full Installation
- Partial Installation

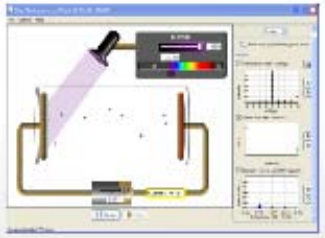
Teacher Ideas & Activities

- Search for lesson plans and activities that were created by teachers to use with the PhET simulations

Contribute

- Provide ideas you've used in class
- Other contributions

Search Simulations

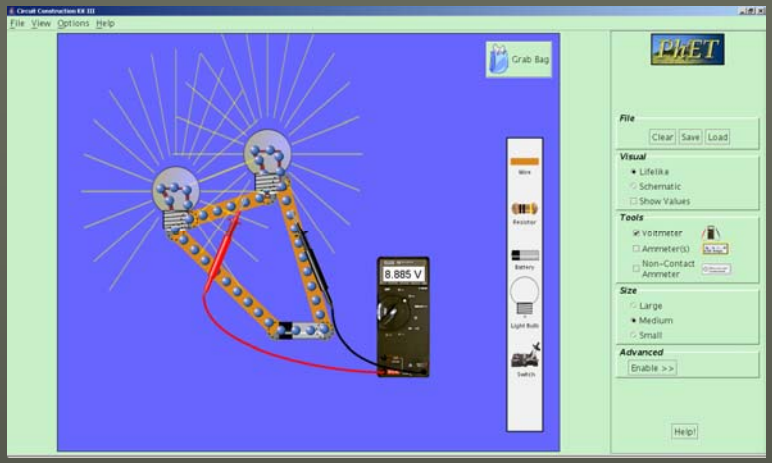


Physics Education Technology Project

- Suite of interactive simulations (~65)
- Covering intro physics, modern physics, bit of chemistry
- Design based on research
- Extensive user testing (usability, interpretation, learning)
- Free! Online or downloadable. (~80 Mbytes)
- Easy to use and incorporate in class

http://phet.colorado.edu

CCK: Group Input

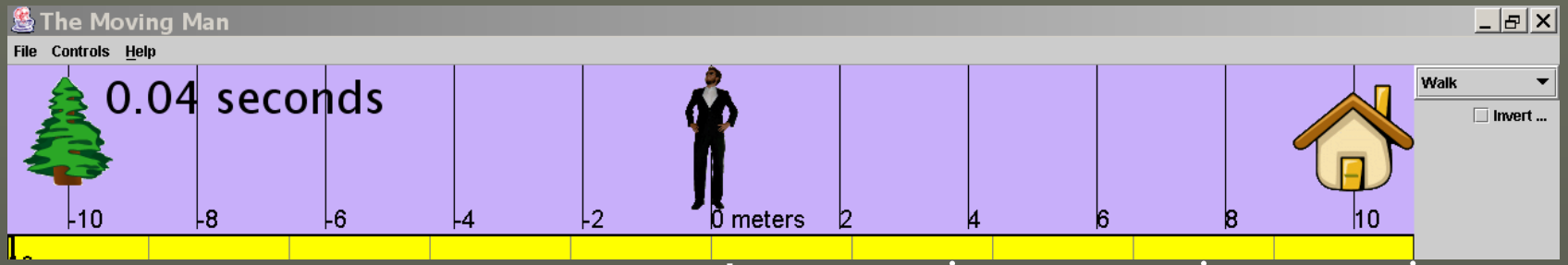


What learning goals does this sim support?

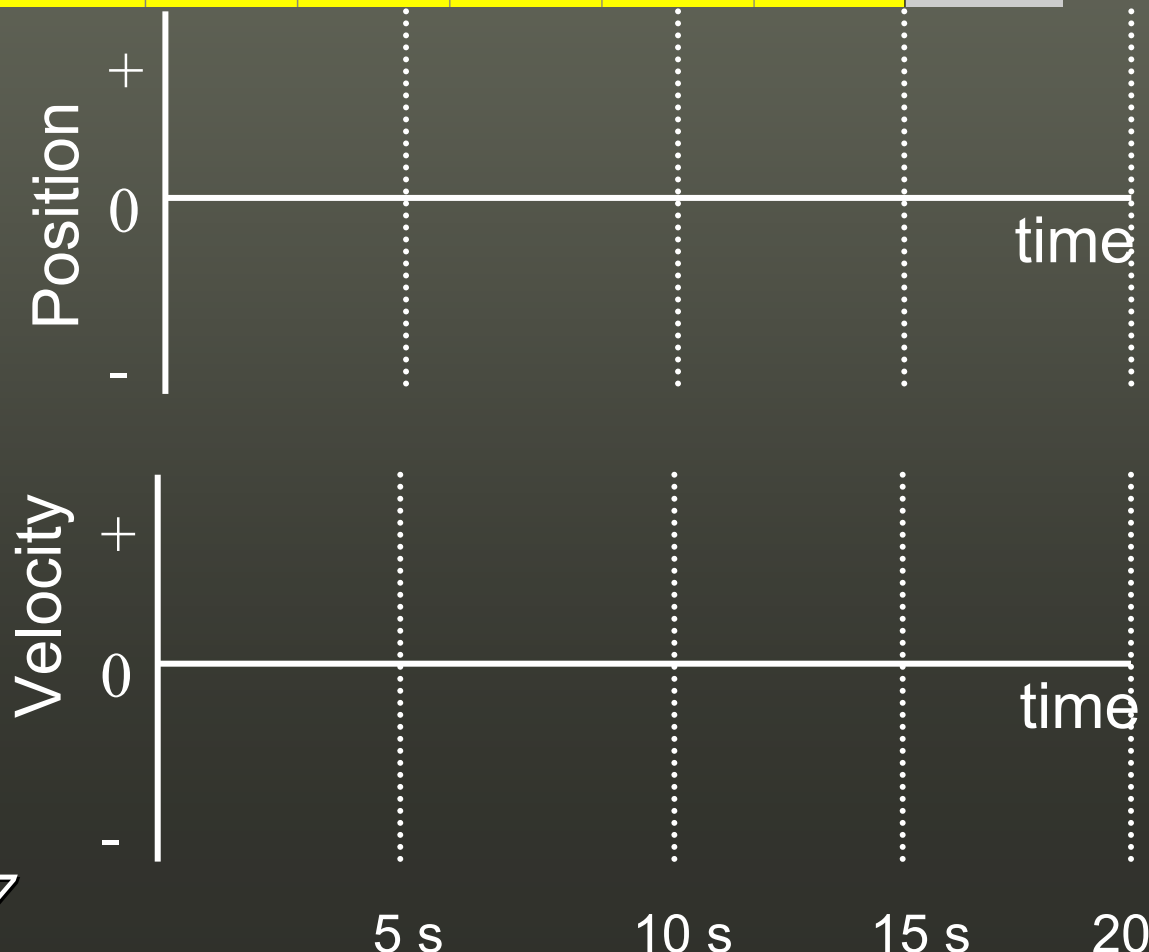
(Any that are hard to reach with traditional approaches?)

How could you use this sim or similar sims in a course?

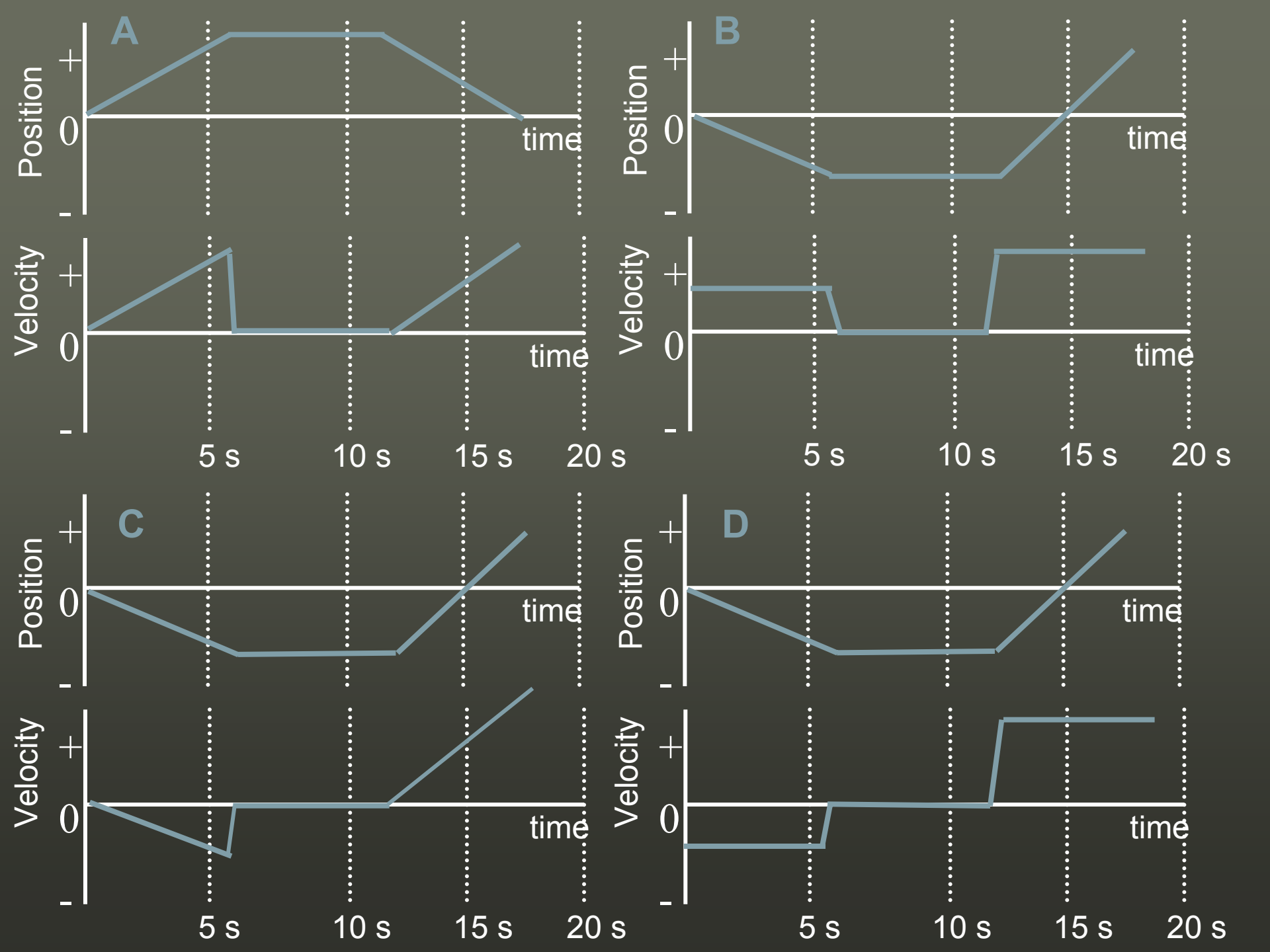
Lecture – Interactive Lecture Demos



Demo 4:
Sketch **position vs time** and **velocity vs time** graphs for when Moving Man:
walks steadily towards the tree for 6 seconds,
then stands still for 6 seconds, and
then towards the house twice as fast as before for 6 seconds.



Thorton and Sokoloff, 1997


A
Position
+
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Velocity
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time
5 s
10 s
15 s
20 s
B
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Position
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time
Velocity
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time
5 s
10 s
15 s
20 s

Use of PhET sims in class

?

Lecture/classroom

Visual Aid, Demo complement,
Interactive Lecture Demos, & Concept tests

Lab and Recitation

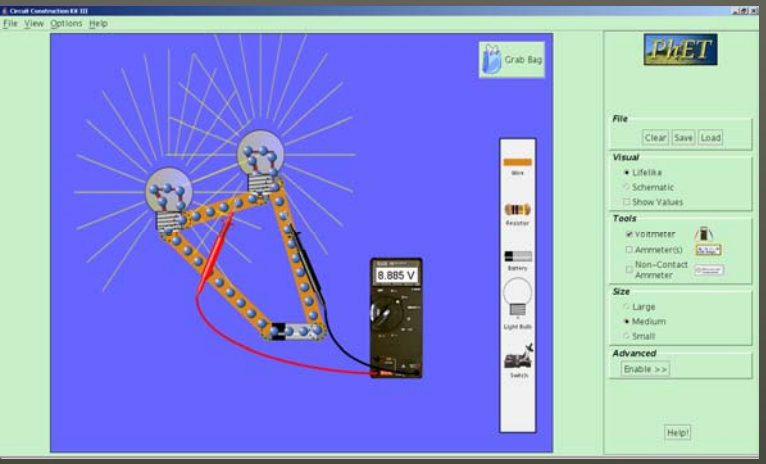
Group activity, Exploration and discovery

Homework

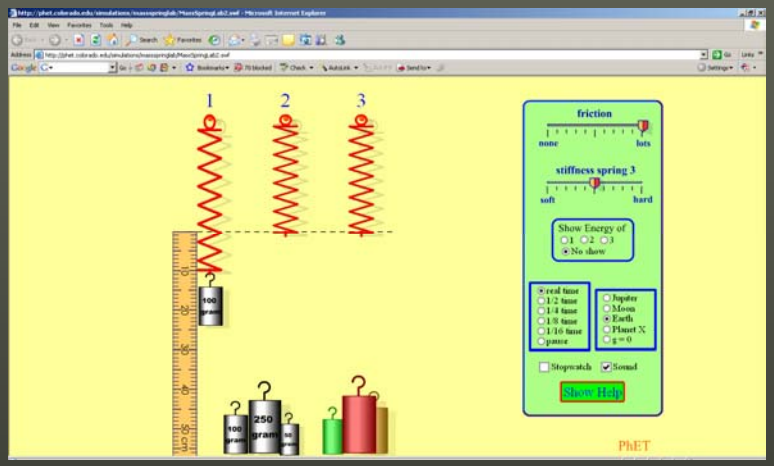
Pre-class assignment – introduce new ideas
Post instruction – develop robust understanding

PhET Design

CCK



Masses and Springs:



What makes these PhET sims particularly effective educational tools?

(Activities should take advantage of these features!)

Design of PhET

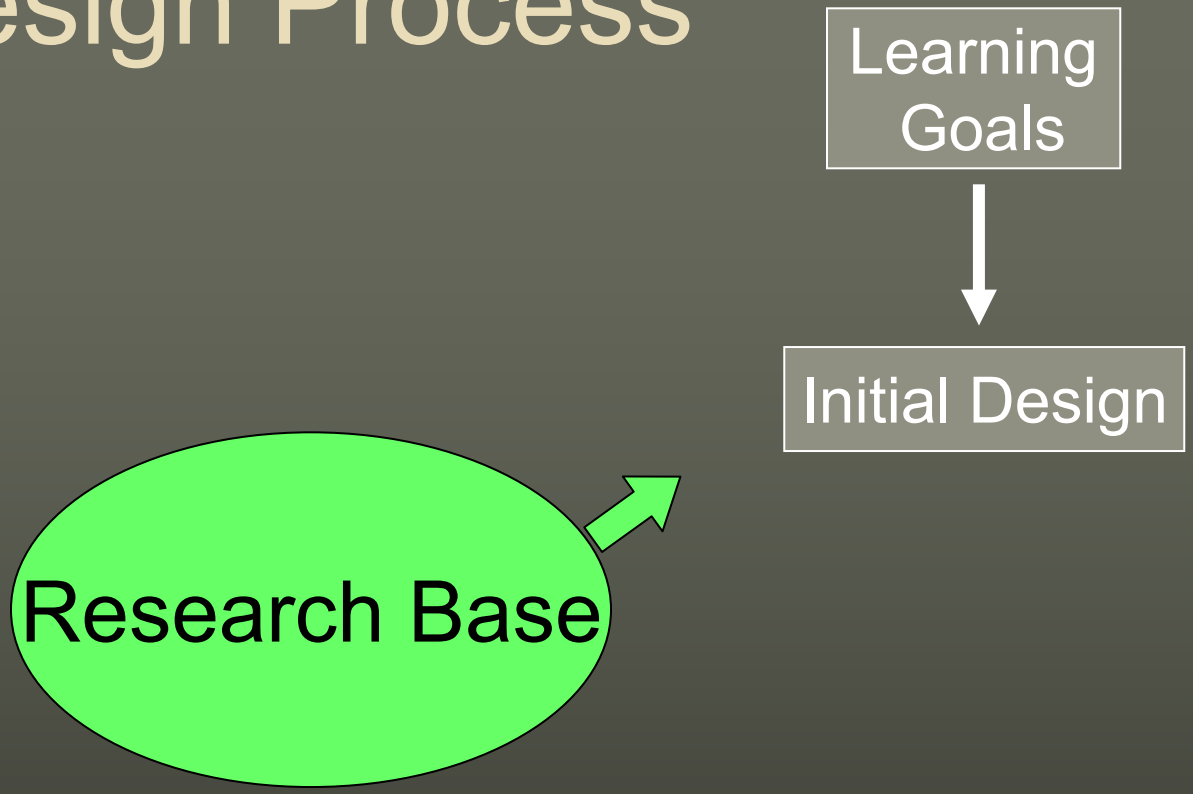
?

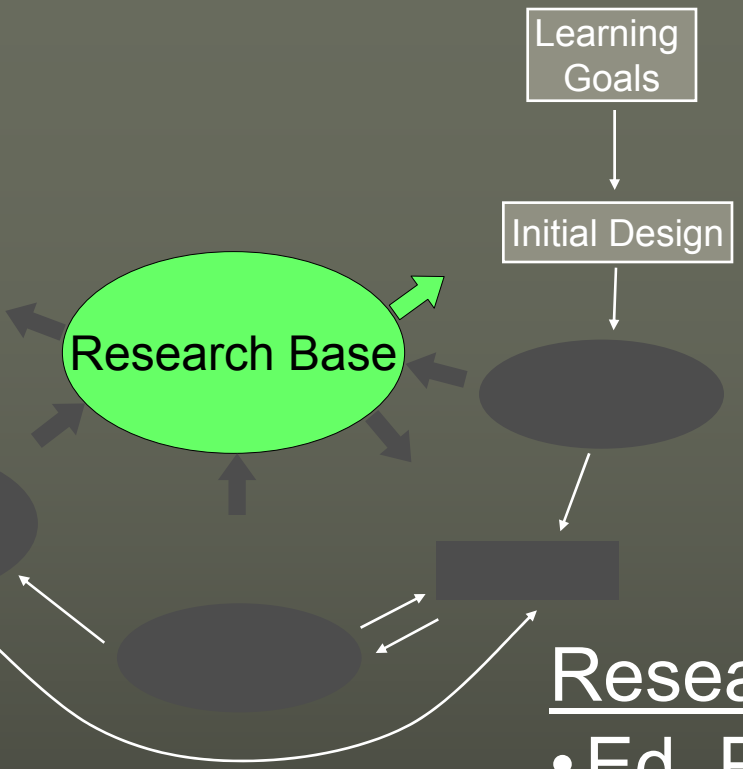
What makes these effective educational tools?

- Engaging, open-style play area
- Highly interactive
- Dynamic feedback. Interaction links to animation.
- Explore and discover (construct understanding)
- Connection to real world
- Explicit visual & conceptual models (that experts use)
- Productive constraints

In folder: K.K. Perkins, et al, “PhET: Interactive Simulations for Teaching and Learning Physics”, *Physics Teacher* (Jan 2006)

Design Process



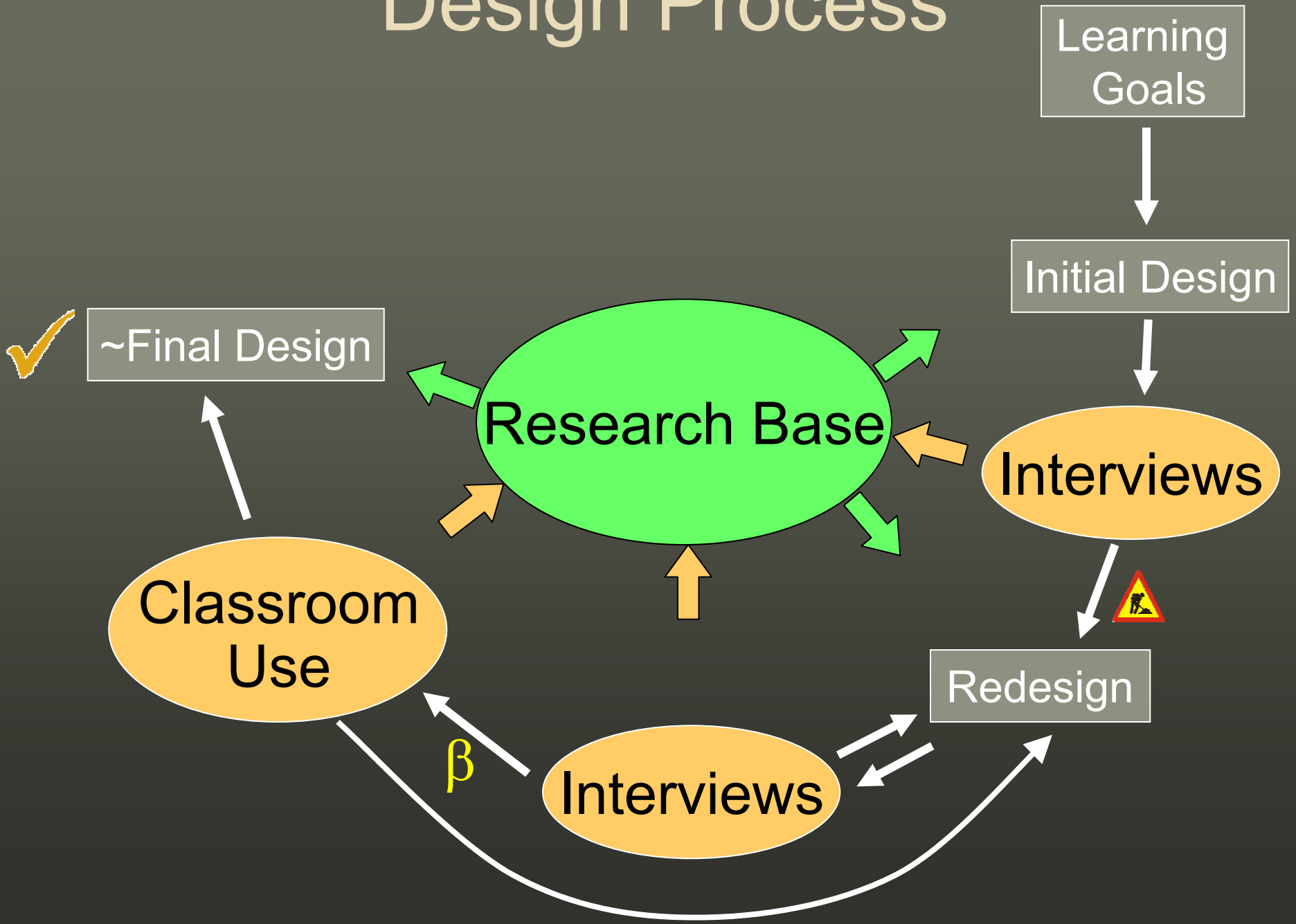


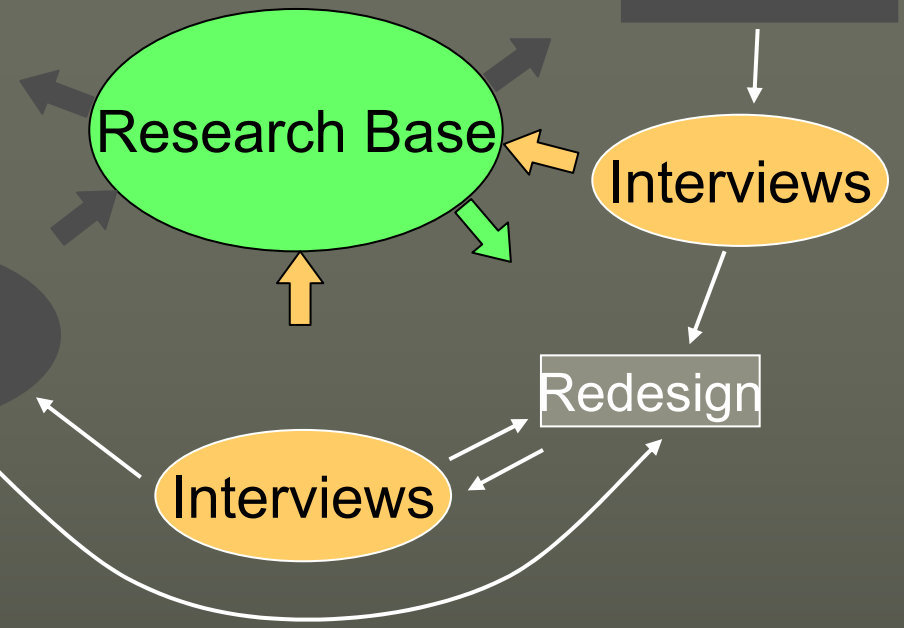
Initial Design & General Approach

Research base:

- Ed. Psych / Cog. Sci: How people learn
- Educational Software Design
- Student Conceptions in Physics
- PhET research findings

Design Process





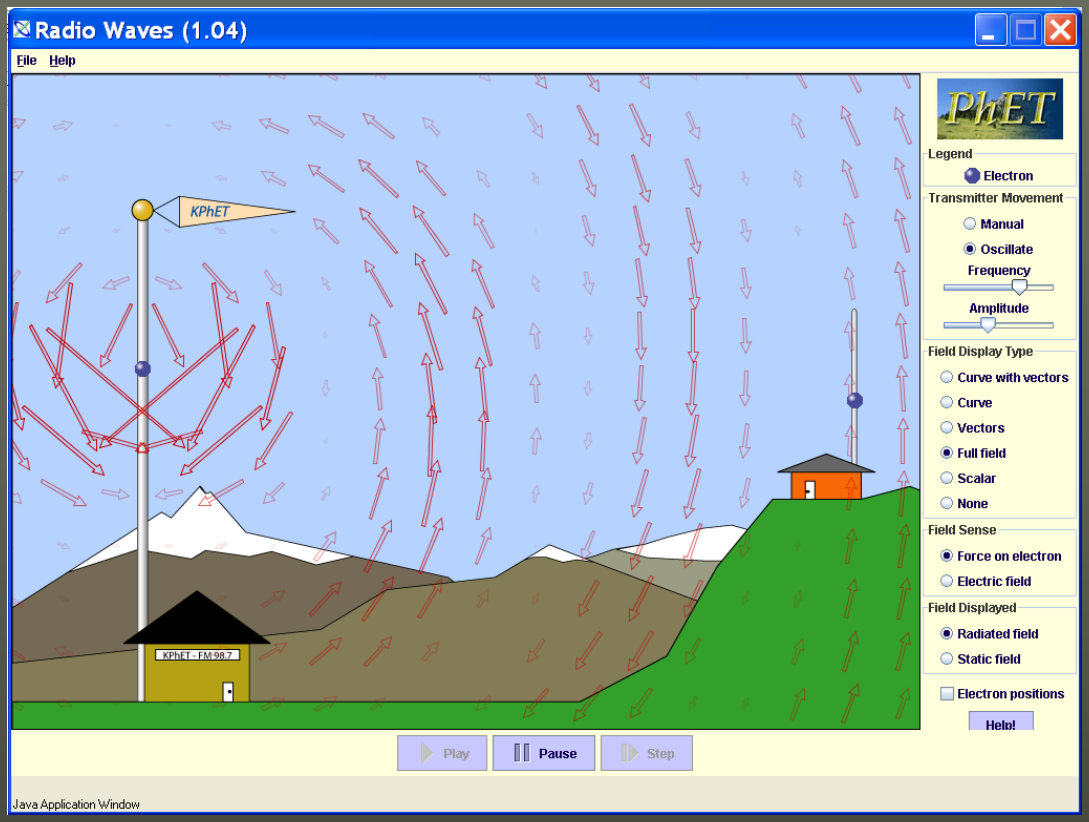
Assessment of Design:

- Usability – easy/intuitive
- Interpretation – correct/productive
- Engaged exploration

} General Design Guidelines

- Can students construct understanding of main ideas? Achieve learning goals?

Paper to appear: Wendy Adams et al.



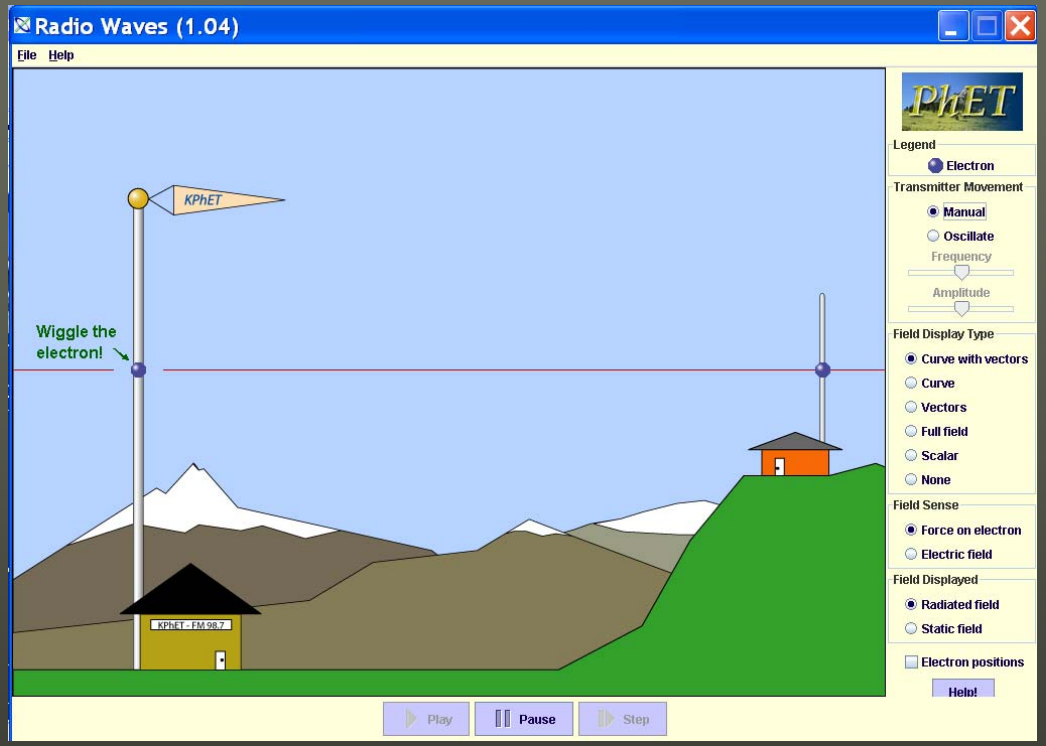
Example- of what revealed by interview studies.

Radio waves.
Initial startup.

Experts- - really like.

Students--Watch without interacting. Don't like. Misinterpret.

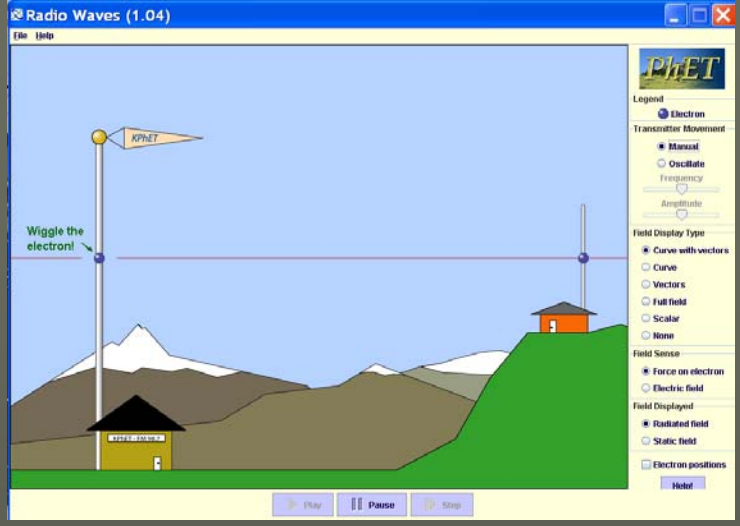
Start with curve view, manually move electron.
Very different result.
Later move to full field view, manipulate, like, and understand.



Correctly interpret.

Why do you think starting this way works so much better?
briefly discuss with neighbors, then will collect ideas

Why starting this way works so much better?



Matches research on learning.

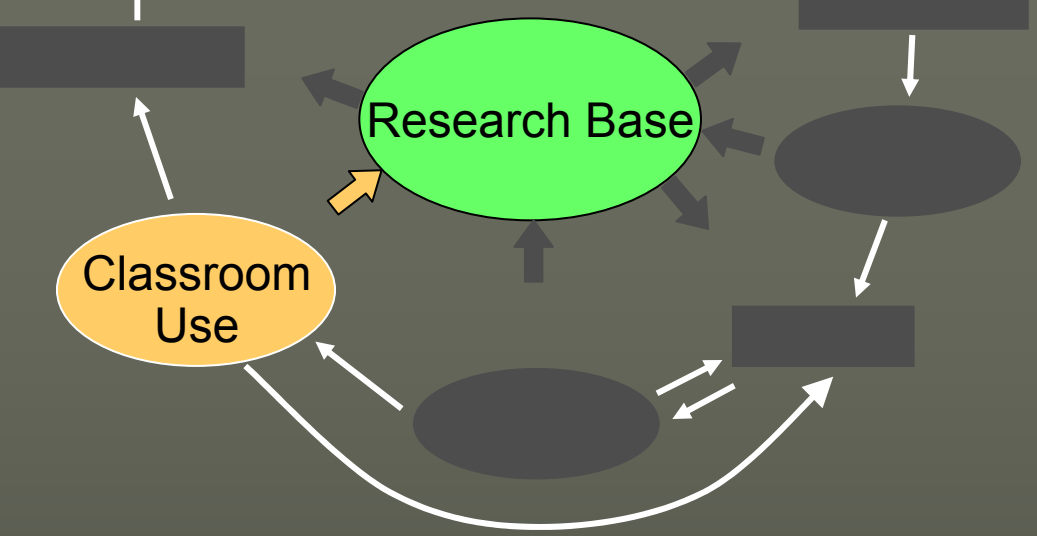
•Cognitive demand. *Novices don't know what to focus on. treat everything equally important. Much more than short-term working memory can handle, overwhelming*

• Construction of understanding.

Other important features:

Visual model-electrons in transmitting and receiving antennas, display of waves

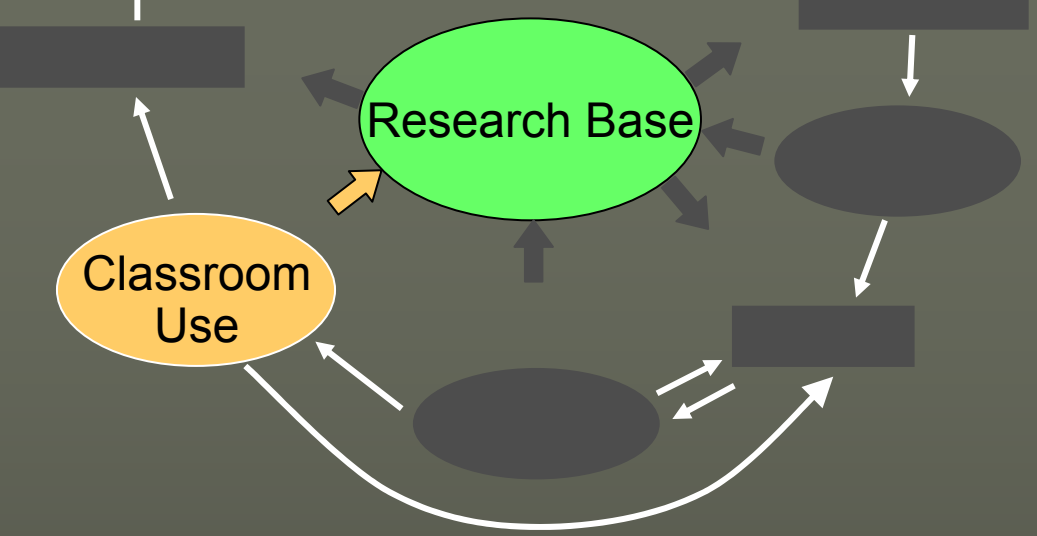
Interactivity



Use of Sims:

- ✓ Well honed tool for learning
- ➢ Doesn't guarantee its effectiveness:
  Effectiveness also depends on how it is used!

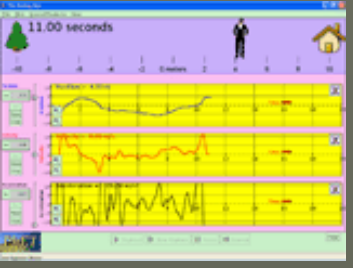
Example papers on research on effectiveness (in folder):
Perkins et al., Physics Teacher
Finkelstein et al., Physical Review - PER



Align Use of Sims with Research on Learning:

Results of Research on How people learn?

1) People learn by actively constructing their own understanding.
2) People learn by building on their own prior knowledge and understanding.
3) Experts build an organized structure of knowledge, and monitor and reflect on their own understanding.



So what's in activity design?

PhET Team Approach to Curriculum Design:
Guided Inquiry Approach

GUIDELINES: Does the activity …

- Address all of your learning goals?
- Require active thinking, sense making / reasoning?
- Build on prior knowledge?
- Connect to real world?
- Help students monitor their understanding?

Activity Design: Moving Man

Make the man start at -5 meter mark, move with constant speed to the 2 meter mark and then accelerate to the 8 meter mark.

A. Sketch the position, velocity and acceleration graphs that you see.

B. How do the three graphs relate?

Sketch what you think a position vs time and a velocity vs time graph will look like for this story:

A man is talking on his cell phone while he stands next to his parked car in front of his house. The phone signal is poor, so he walks toward his house trying to get a better signal and then stands still to finish his conversation.

A. Explain why each part of your graph makes sense.

B. Test your ideas using the simulation

What might students learn in each activity?
Are these aligned with guidelines?

Workshop Goals

✓1. Become familiar with PhET simulations
- What makes PhET sims unique learning tools?
- How can they be used in class? (*easy, effective)*

(Break)

Find best-matched partner for 2nd part of workshop

2. Plan for sim use in your class
- Identify useful PhET sims
- Find useful Activities
- Develop your own activity (~1.5 hours)
- Report out on:
  - learning goals addressed
  - activity
  - guidelines addressed.

What is your course and population?

- On note card please write:
  - Your name
  - Your school affiliation and location (city, state)
  - Course and student population with which you want to use PhET sims
  - Also indicate if you are already using PhET

On back:
- email
- regular mailing address

(if you want a PhET CD)

Mingle, Find partner

ho

With Partner: Planning out sim use

- Browse entire PhET website
- Match up topics/concepts you teach with sims
- Think a bit about how you might use each:
  - pre-class assignment?
  - in lecture concept test or interactive lecture demo?
  - in-class activity?
  - homework?
  - other?

~20 minutes

Searching the Activities Database (Handout)

- Search by:
  - Simulation
  - Level
  - Author
  - Type of Activity
  - Topic
  - Keyword

Searching the Activities Database

- Pick a simulation
- Search for and Review Activities (10 min)

- Report out on what you found

ho

Develop an activity

- Choose the sim
- Choose learning goals you want to address
- Choose guidelines you will focus on
- Draft activity

•At end, groups will report out on:
Learning goals, sim chosen, activity, guidelines

ho

Get/give feedback & revise activity

- Pair up with another group
- Review their activity and give feedback

  Where are guidelines are well applied in this activity?

  Suggestions for improving alignment with guidelines?

- Revise based on feedback

~30 min

Pairs Report Out

What simulation did you use?

What learning goals did the simulation support?

Which guidelines did you address?

What makes the simulation an effective learning tool ?

Stay in touch

- http://phet.colorado.edu
- Search/post to database of activities!
- Suggestions welcome