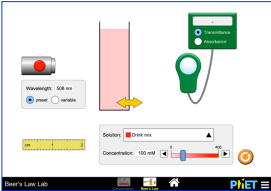
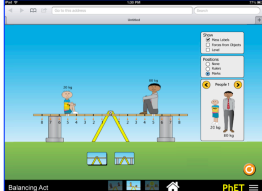
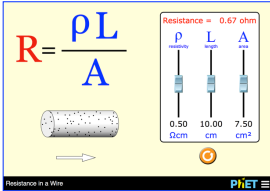


Tools for Teaching Mathematics


A suite of *free* interactive simulations

Karina K. R. Hensberry and the PhET Team


<http://phet.colorado.edu>

CCTM Conference, October 11, 2013
Denver, CO



Workshop Goals

- Discover PhET and example simulations
- How are the simulations created?
- How do PhET sims help students learn?
- How can sims be used?



C. Pribyl, Alabama

Introductions

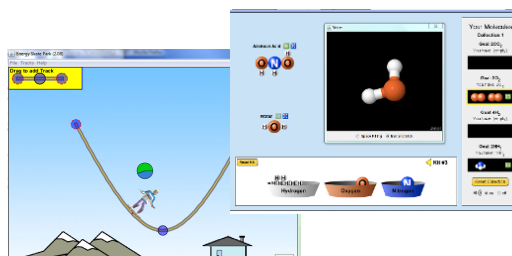


- What is your role?
 - Teacher
 - Grade level?
 - Teacher Educator/Researcher
 - Administrator, coach
 - Other
- How many people here...
 - Are new to PhET?
 - Have seen or heard of PhET?
 - Have used PhET sims in their own teaching?

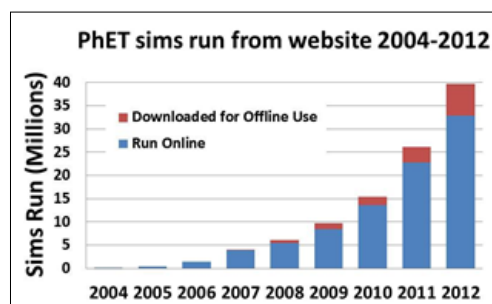
Discover PhET



- Suite of >125 interactive science and mathematics simulations
- **Free** at <http://phet.colorado.edu>
- Run online or download for offline use (~320 MB)
- Over 25 million sims run in 2012



*<http://phet.colorado.edu>

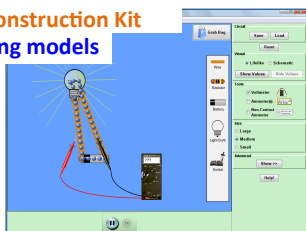


Discover PhET



Variety of simulations with different goals and features

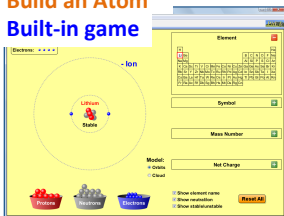
Circuit Construction Kit Underlying models



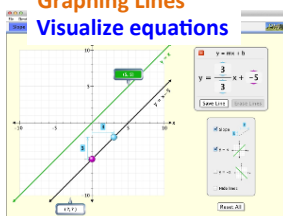
Balancing Act Lab with unknown quantities



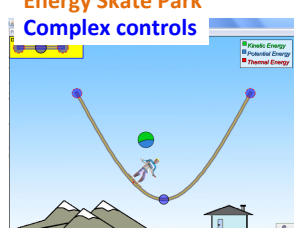
Build an Atom Built-in game



Graphing Lines Visualize equations



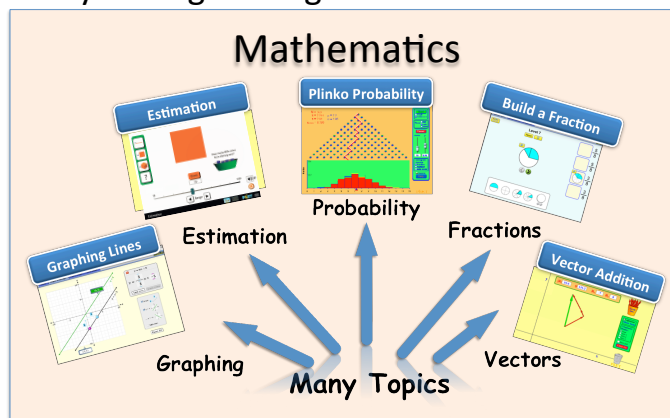
Energy Skate Park Complex controls



Content areas



- Physics, chemistry
Some in math, biology, earth science
- Elementary through college



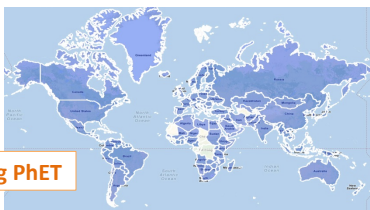
Why is PhET Successful?



PhET is Accessible

- Open-use License: Creative Commons - Attribution
- Easily translatable: Over 4700 sim translations in 73 languages
- Website in 30 languages
- 34% of use is outside the U.S.

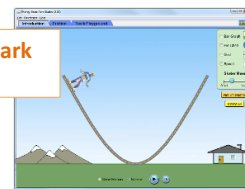
Countries using PhET



Brazil

能量滑板竞技场: 基础

Energy Skate Park in Chinese



下载 大小: 2.790 kB 直接运行!
嵌入代码 版本: 2.13 (修改记录)

Why is PhET Successful?



PhET is free

- NSF
- Hewlett Foundation
- The O'Donnell Foundation
- Collaborative agreement with King Saud University
- University of Colorado
- Carl Wieman & Sarah Gilbert
- And others, including individual teachers, you, schools, districts, and corporate and foundation sponsors



THE WILLIAM AND FLORA HEWLETT FOUNDATION

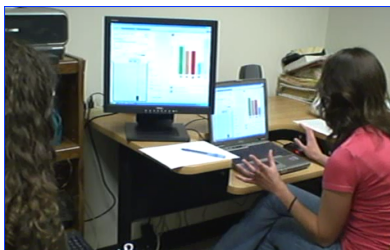


Why is PhET Successful?



PhET is based in research & user design

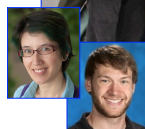
- User interviews
- Classroom testing
- Research-based
- Diverse design team



How are sims created?



The PhET Team builds simulations and studies the use of simulations in education



CU Boulder team of scientists, researchers, software developers, and educators

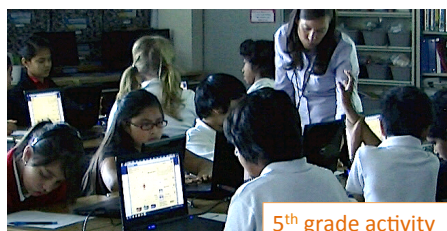


How do PhET sims help students learn?



Adaptable for a variety of learners

- Pick and choose sims by topic, keyword, or grade level
- Customize to your environment and your goals
- Search database of over 900 activities* by PhET and teacher-users

5th grade activity

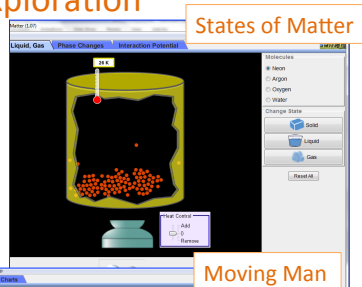
College lecture

How do PhET sims help students learn?



The intentional design of PhET simulations supports productive student exploration

- **“Productive constraints”**: Provide limited choice of controls
- **Dynamic feedback** links interactive and animated elements
- Explicitly shows visual & conceptual **models that experts use**
- **Based on research** on how people learn*



States of Matter



Moving Man

Design Principles in Action

PhET
INTERACTIVE SIMULATIONS

Fractions Intro*

Interactive

Constraint:
Only improper fractions

Layered complexity

Multiple, accurate, dynamic representations

Pedagogically powerful actions

Intuitive interface

Design Principles in Action

PhET
INTERACTIVE SIMULATIONS

Fractions Intro*

Real-world connections

Layered complexity

Affordances: Build fractions, set partitions

Cueing; Game-like, fun, engaging, open

Dynamic Feedback

How do PhET sims help students learn?

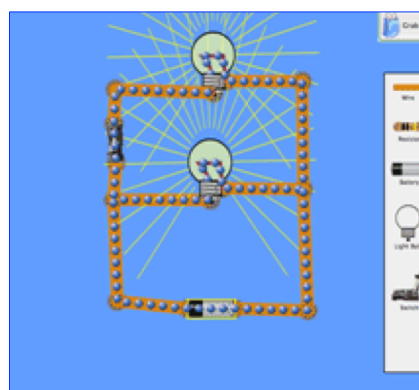


Flexible tool: Adaptable for a variety of learners

Circuit Construction Kit Sample student prompts

CCK in elementary school:
“Make the light bulb light.”

CCK in high school:
“Explain why the light dims when you turn the heater on.”

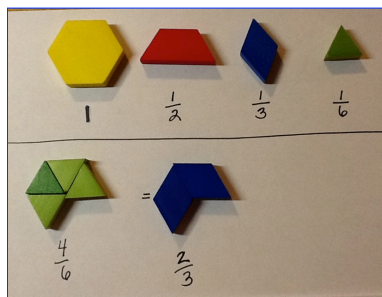
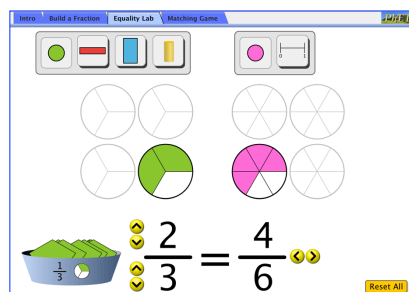


Circuit Construction Kit

How do PhET sims help students learn?



What are the advantages of simulations vs. real equipment?



Thoughts on these tools?

Broad Objectives for Students

Accessible, Understandable, and Fun

Connections to Everyday Life

Conceptual Learning

Engage in Exploration

Sense of Ownership



How can sims be used?

Lecture/Front-of-the-classroom

Visual Aid, Demo complement,
Interactive Lecture Demos, & Clicker Questions

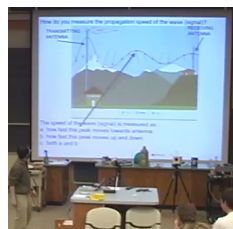
In Class, Lab, Recitation *What do you think?*

Group activity, Exploration and discovery

As Homework

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

Instructor vs. Student Control



The Teacher

The Students



How can sims be used?



Lecture/Front-of-the-classroom



Teacher-
Controlled

In Class, Lab, Recitation

As Homework

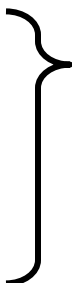
How can sims be used?



Lecture/classroom

Lab and Recitation

Homework



Opportunity for
student expert-like
exploration and
engagement in
problem solving

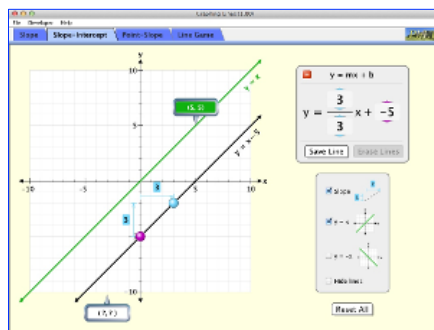
But, no silver bullet:

Context, Activity, Facilitation
critical

How can sims be used?



Remember: Simulations designed for exploration



Graphing Lines

How can sims be used?



Investigate sample activities*

How many come up represent

You explain who has not m that $1/3 =$

Reset All

1. What will students be doing in each activity?
2. What will students learn in each activity?
3. What is the teacher doing?

Fractions Intro

How can sims be used?



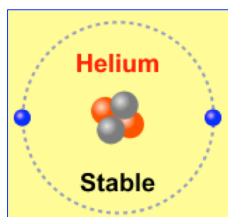
Pre-class Homework

- Before the next class, write a function for an atom's mass. What are the independent and dependent variables?

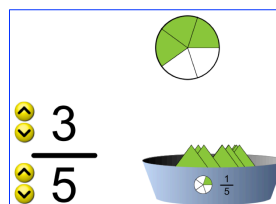
Lecture

- Concept tests: How will changing the numbers in the fraction affect the

Other examples



Build an Atom



Fractions Intro

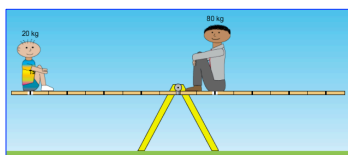
How can sims be used?



Recitation

- Use the simulation to describe at least two ways to balance objects with different masses.

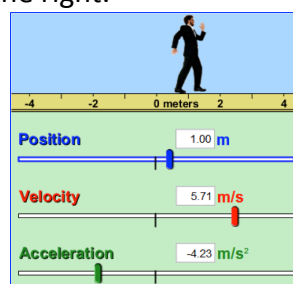
No lab equipment required!



Balancing Act

Demos

- List the minimum information required to know the man is moving to the right.



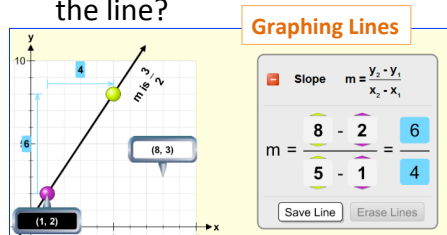
Moving Man

How can sims be used?



Post-class Homework

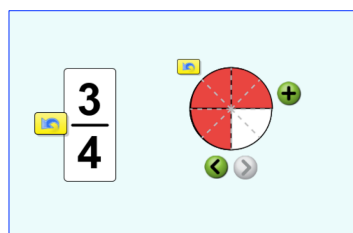
- Test your ideas about slope with the *Graphing Lines* sim. What is the largest slope you can make? The smallest? How does changing the slope affect the line?



Graphing Lines

Discussion

- Find another fraction equivalent to $\frac{3}{4}$. Explain how you know the two fractions are equivalent.



Build a Fraction

How can sims be used?



Tips for productive inquiry

- 5-10 minutes of open play at start
 - Establishes student ownership for sim
 - Students get familiar with controls
- Avoid explicit instruction on how to use the sim
 - Sims are intuitive to use; focus students on exploration
- Use open, investigative questions and concept tables
 - “Design an experiment,” or “How can you make...?”
- Solicit students’ ideas
 - Ask students to demonstrate findings, engage in problem solving
- Use “Creating PhET Activities” handout
 - <https://phet.colorado.edu/en/for-teachers/activity-guide>

How can sims be used?

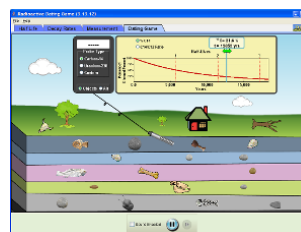


Think outside the box!

Sims are very flexible in terms of content & grade level.

e.g. Radioactive Dating Game

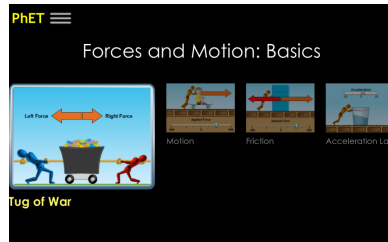
- **Chemistry** (compare half-life and use)
- **Biology** (identify fossils)
- **Earth Science** (age of layers)
- **Math** (exponential relationships)
- **Variety of grade levels** (elementary, middle, HS, AP)
- **Combine with other sims** (Use Alpha and Beta Decay sims to explain underlying model)



Coming Soon!



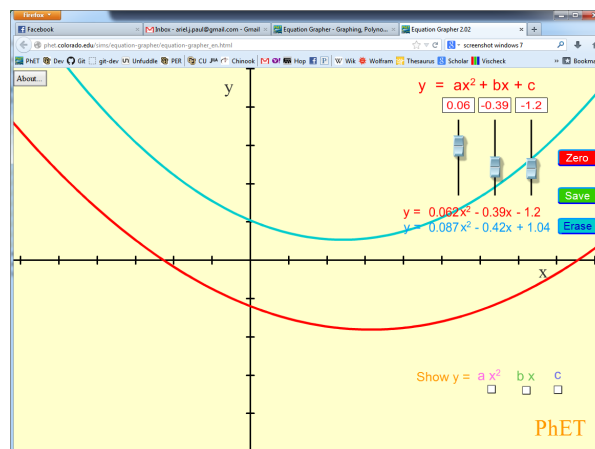
HTML5/Touch/iPad



Coming Soon!



HTML5/Touch/iPad



Coming Soon!



HTML5/Touch/iPad




TRY OUR NEW HTML5 SIMS





Coming Soon!



HTML5/Touch/iPad

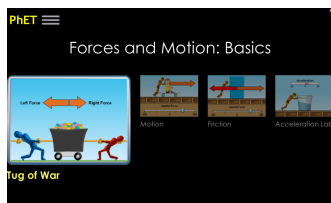


- Estimation (redesigned)
- Balancing Act (redesigned)
- Fractions suite
- Fraction Comparison
- Graphing Lines
- Graphing Quadratics
- Vector Addition (redesign)

Coming Soon!



HTML5/Touch/iPad



- Estimation (redesigned)
- Balancing Act (redesigned)
- Fractions suite
- Fraction Comparison
- Graphing Lines
- Graphing Quadratics
- Vector Addition (redesign)

“Teach with PhET” website (coming Spring 2014?)



Want more information?



- Website: teacher resources
- Flyer
- Check out videos at www.youtube.com/PhETInteractiveSims
- Visit our booth!

Thank you!



- Questions?
- Give us feedback!
 - Suggestions for sim topics
 - Share your activities

karina.k.hensberry@colorado.edu

<http://phet.colorado.edu>

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