



# Incorporating Simulations in the Classroom

## A Survey of Research Results from the Physics Education Technology Project

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# What is PhET?

- Highly interactive, visual simulations (~35)
- Learning and teaching physics
- Fun, bridge to real world, open, visual/conceptual models
- Research-based and user-tested
- Freeware, Online or downloadable

<http://phet.colorado.edu>

# Use and effectiveness

## Type of Use

## Research Study

Independent

Interviews

Pre-class assignments

Sims vs. Reading

Lecture ←

Visual Aids, ILDs, & Concept tests

vs. real demo

vs. static pict/words

Lab ←

vs. real equipment

Homework

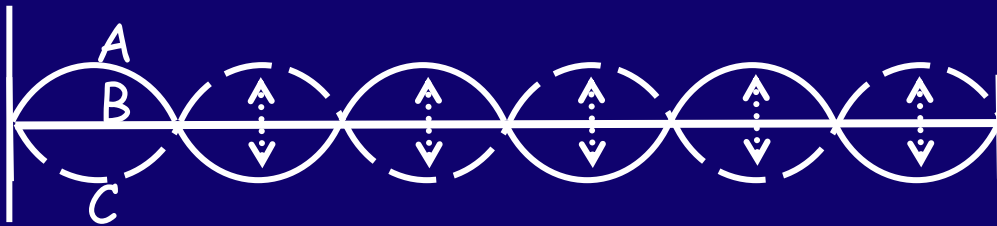
vs. no sim

# Effectiveness for student learning:

## Lecture

Violin string and harmonics:

Show wave  
on a string



snapshots at  
different times.

When the string is in position B, instantaneously flat, the velocity of points of the string is...

- A: zero everywhere.      B: positive everywhere.  
C: negative everywhere.    D: depends on the position.

**Correct :**  
**2002 demo: 27%**  
**2003 sim: 71%**

Follow up question: At position C, the velocity of points of the string is...

- A: zero everywhere.      B: positive everywhere.  
C: negative everywhere.    D: depends on the position.

**Correct :**  
**2002 demo: 23 %**  
**2003 sim: 84%**

# Effectiveness for student learning:

## Lab: Circuits

|   | <u>Simulation<br/>Group (N=99)</u>                    | <u>Traditional<br/>Group (N=132)</u> |
|---|---|--------------------------------------|
| Constructed circuits  | Show CCK<br>Sim: Circuit<br>Construction<br>Kit (CCK) | Real parts                           |
| Predict/measure equivalent<br>resistance                        |   |                                      |
| Predict/observe/explain<br>circuit behavior                     |   |                                      |
| Circuit Challenge:<br>Build/observe/explain<br>circuit behavior | Real parts  | Real parts                           |

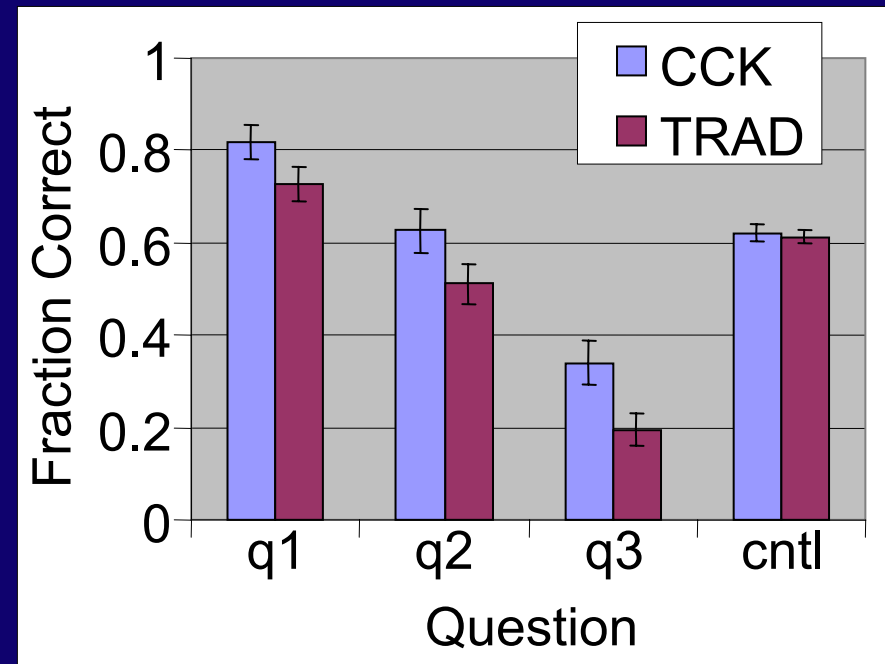
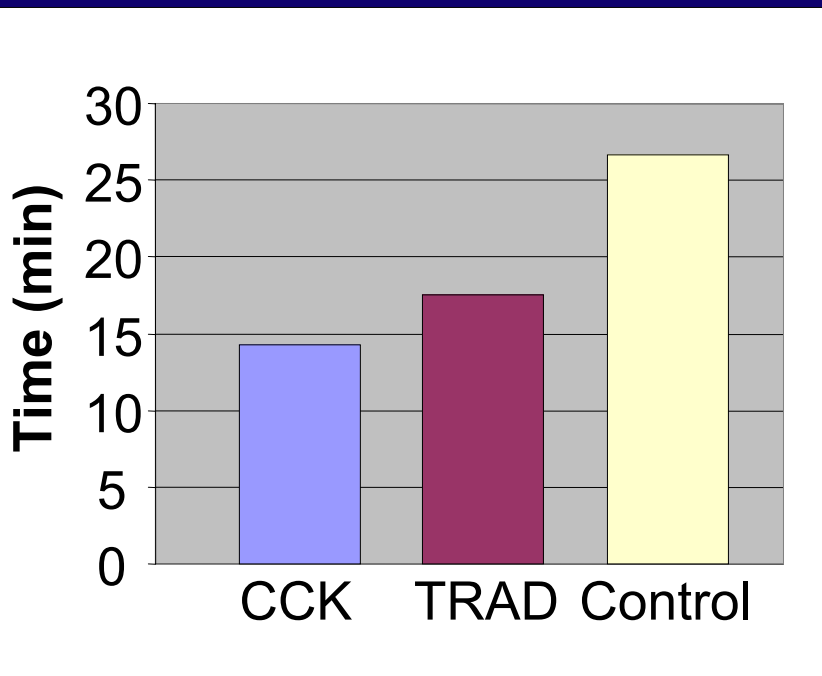
# Results for Lab Study

Real circuit construction

Conceptual Understanding

Data: Time to build and evaluate circuit

Data: Final Exam



Mean score on Q1-Q3:

CCK = 0.59 , TRAD = 0.48

Statistically different,  $p < 0.001$

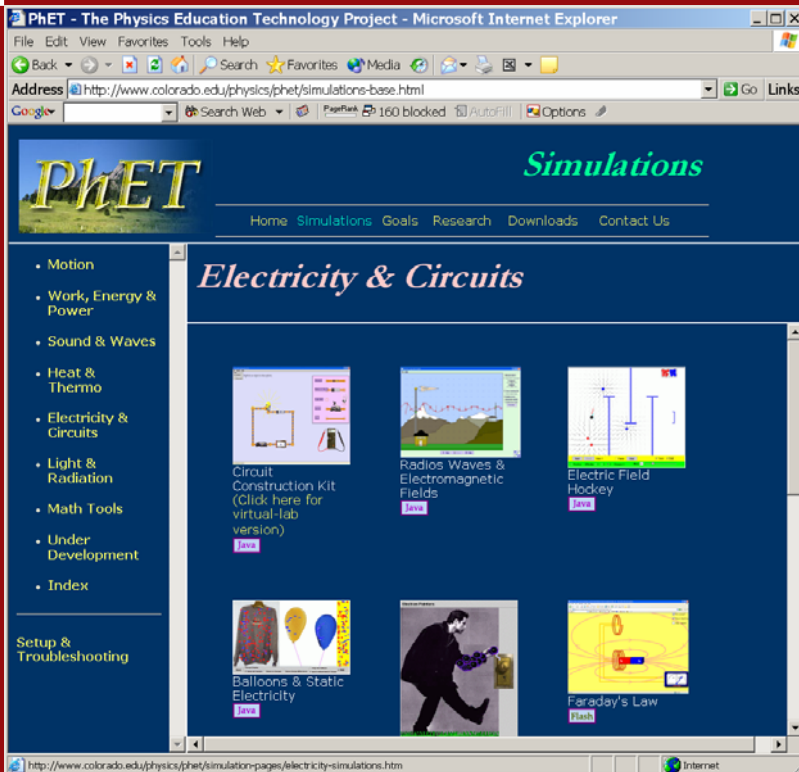
# Summary

- Two studies: simulations effective for learning
- Not automatically true,
  - Research/testing is critical
  - Context dependent

# Summary

## Website

phet.colorado.edu



## PhET Exhibit Booth

Laptops to explore sims

Posters on:

- Project Overview
- Design principles
- Design philosophy