INTERACT

DISCOVER

LEARN

HTTP://PHET.COLORADO.EDU

PhET INTERACTIVE SIMULATIONS

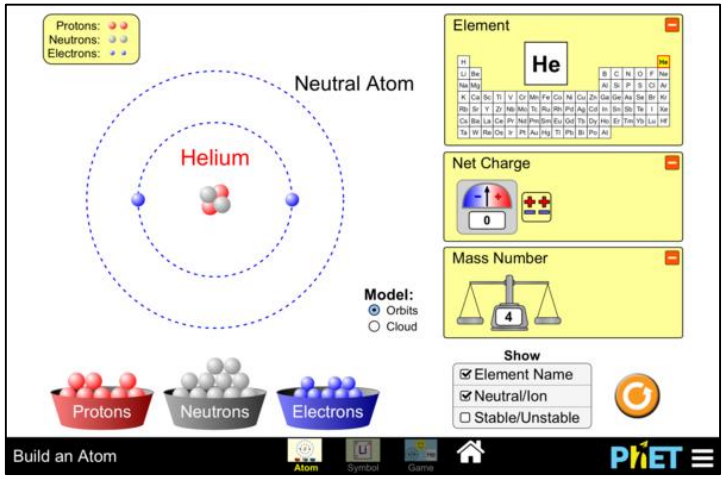
University of Colorado Boulder

GOALS: TO MAKE STEM LEARNING MORE ….

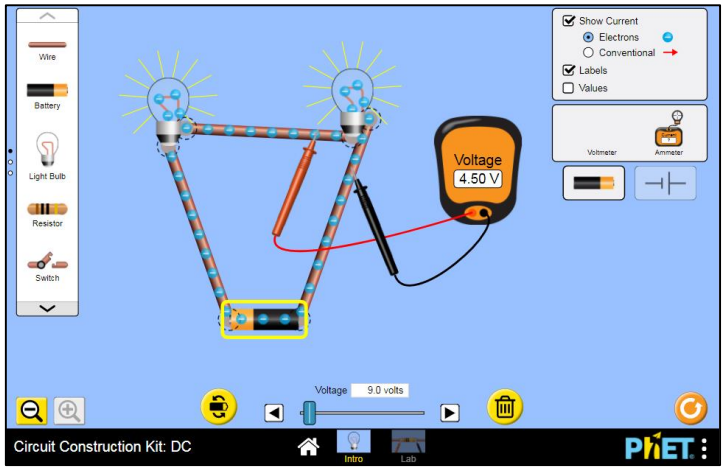
ENGAGING	Interact and discover key ideas.
RELEVANT	Connect to everyday life.
ACCESSIBLE	Intuitive and understandable.
EFFECTIVE	Use STEM practices. Develop conceptual understanding.
PERSONALIZED	Students direct their learning.

THROUGH POWERFUL PEDAGOGICAL TOOLS

Build an Atom
Grades 5 thru College
~6M uses/yr
A next-generation HTML5 PhET Sim



Circuit Construction Kit
Grade 5 thru College
~6M uses/yr
Released in HTML5 (Oct 2017)



ENGAGING ENVIRONMENT

INTUITIVE INTERFACE

HIGHLY INTERACTIVE

SCAFFOLDED THROUGH DESIGN

ACCURATE, DYNAMIC VISUAL REPRESENTATIONS

REAL WORLD CONNECTIONS

SHOWS THE INVISIBLE

REAL-TIME, ANIMATED FEEDBACK

ALLOWS ACTIONS NOT POSSIBLE IN THE REAL WORLD

MILESTONES AND AWARDS

2002 Founded by Carl Wieman, Nobel Laureate in Physics

2005 Published first study of PhET effectiveness in the college classroom

2006 50 sims; licensed CC-BY; 1.8 million uses

2008 Expansion to chemistry and translation infrastructure

2010 Expansion to middle-school science sims

2011 100 sims; 600 activities; 30 publications; 25 million uses/year

2013 Published first HTML5 PhET sim, with touch and tablet support

2015 Expansion to math, STEM assessment, and accessibility. Published first PhET-iO prototypes.

2018 149 sims; 1800 activities; 60 publications; 100 million uses/year; 93 languages
Published several accessible sims (with full screen-reader and keyboard access)

2006

2007

Visualization Challenge

2011

$50,000 Prize

2014

$25,000 Prize

2015

Presenters', Facilitators', & Public Choice

2017

$20,000 Prize

2018

Excellence in Physics Education
$5,000 Prize

PHET TEAM MEMBERS

Kathy Perkins

Director

BA, MA, PhD Harvard University
Associate Professor, CU Boulder
Joined PhET in 2003
Directed PhET since 2008

Carl Wieman

Founder and Senior Advisor

Nobel Laureate in Physics
Professor, Stanford University
Chair, NAS Board on Science Education (2004-9)
Associate Director of Science at OSTP (2010-12)

2019 PHET TEAM

15 FULL-TIME, 21 PART-TIME TEAM MEMBERS

K12 and College Education Specialists
150+ years of teaching and experience in STEM education

Sim Design Experts
100+ years of design and study of PhET sims

Software Development Team
50+ years of PhET sim development

Education Researchers in STEM learning
60+ articles on PhET sim design and learning

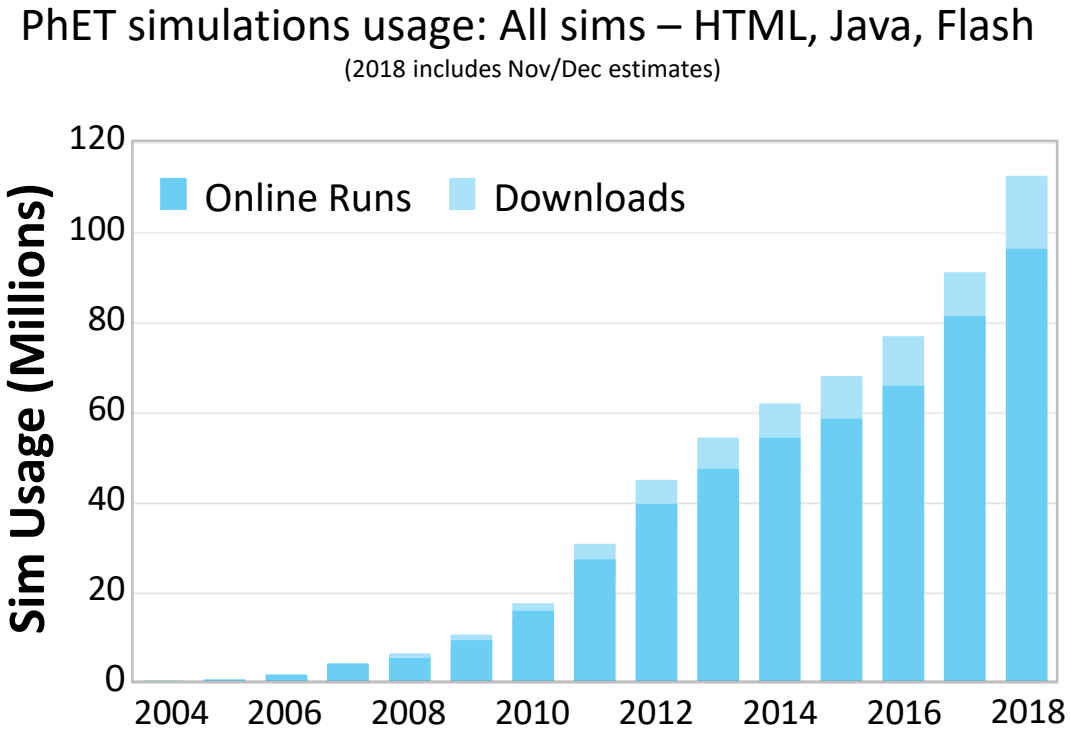
Content Experts/PhDs
in physics, chemistry, and math

Quality Assurance Team
of dedicated undergraduate assistants

plus **Administrative, Marketing, Graphic Design, Fundraising team members**

http://phet.colorado.edu/en/about/team

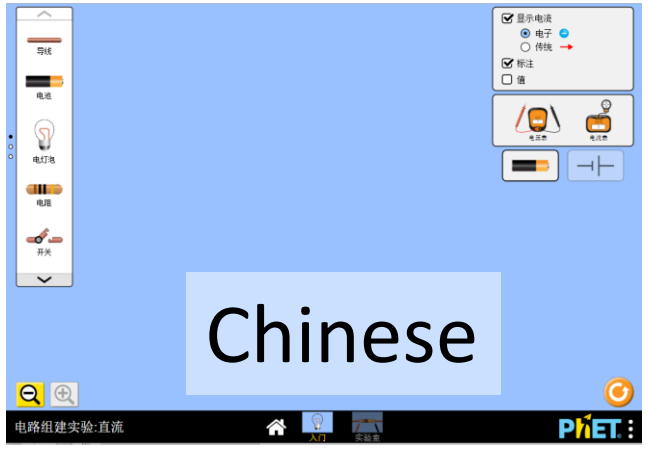
CURRENT POSITION AND IMPACT

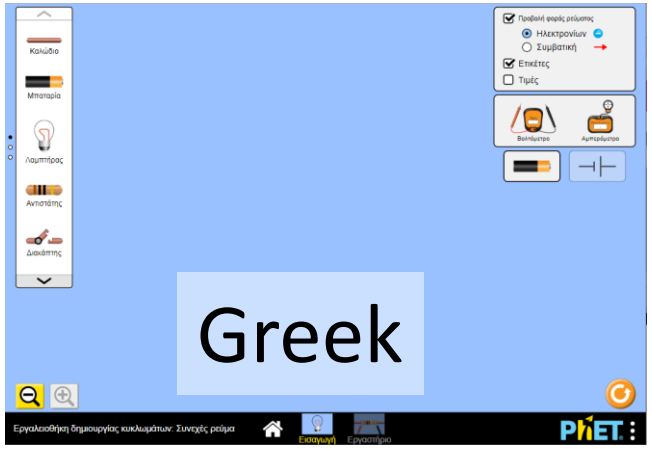


Simulations:	152 sims; 73 sims in HTML5 (79 legacy sims to move to HTML5)
License:	CC-BY
Teacher resources:	1800+ lessons; PD videos & docs
Widespread usage:	>100 million sim uses/yr
Broad user base:	K-12 and college, worldwide
Global adoption:	Sims in 93 languages Used in 200 countries/territories
Product Integration:	20+ companies using PhET CC-BY e.g. Pearson, STEMscopes, Nearpod
Software code:	Innovative HTML5 solution
Impact data:	60+ publications on design, classroom use, and effectiveness

MAJOR FUNDERS: NSF · The William and Flora Hewlett Foundation · Gordon and Betty Moore Foundation · Google.org · newschools venture fund · CU

SIM TRANSLATIONS - 93 LANGUAGES





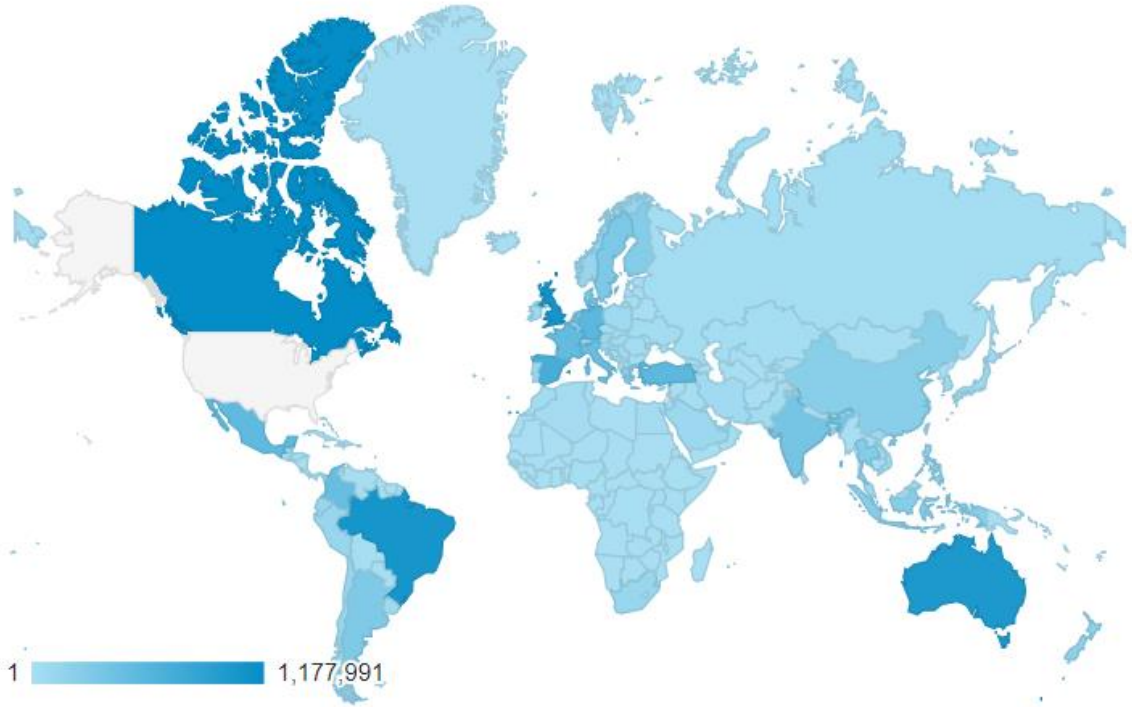
All translations completed by our volunteer translator community.

WEBSITE TRANSLATIONS - 43 LANGUAGES

Arabic (Saudi Arabia)
Basque
Belarusian
Bosnian
Chinese (China)
Chinese (Taiwan)
Czech
Danish
Dutch
English
Estonian
Finnish
French
Gallegan
Georgian
German
Greek
Hungarian
Indonesian
Italian
Japanese
Korean
Kurdish
Kurdish (Turkey)
Macedonian
Marathi
Mongolian
Norwegian Bokmål
Norwegian Nynorsk
Persian
Portuguese
Portuguese (Brazil)
Romanian
Serbian
Sinhalese
Slovak
Spanish
Spanish (Mexico)
Spanish (Peru)
Thai
Turkish
Ukrainian
Vietnamese

GLOBAL USAGE

~32% of PhET usage is international.



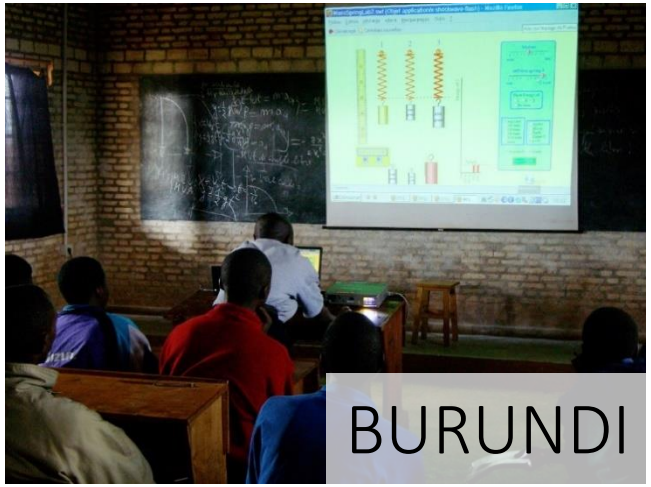
U.S. data excluded from map

High use countries: 38 countries with >100,000 sessions/yr

High use languages: 30 languages with >100,000 sim runs/yr

Top 25 countries by online use:
Canada, United Kingdom, Brazil, Australia, Spain, Germany, Turkey, France, Mexico, Italy, Colombia, India, Netherlands, Denmark, Thailand, Argentina, Sweden, China, Indonesia, Greece, Philippines, Singapore, Finland, New Zealand, Belgium

GLOBAL IMPACT



WITH DISTRIBUTION PARTNERS LIKE …

LEARNING EQUALITY

PhET simulations are integrated into Kolibri from Learning Equality – providing offline use of simulations to broad populations, including refugees.

Learnira

Learnira is training teachers in Nigeria to use PhET simulations and distributes PhET's offline installer for classrooms without internet.

openstax™

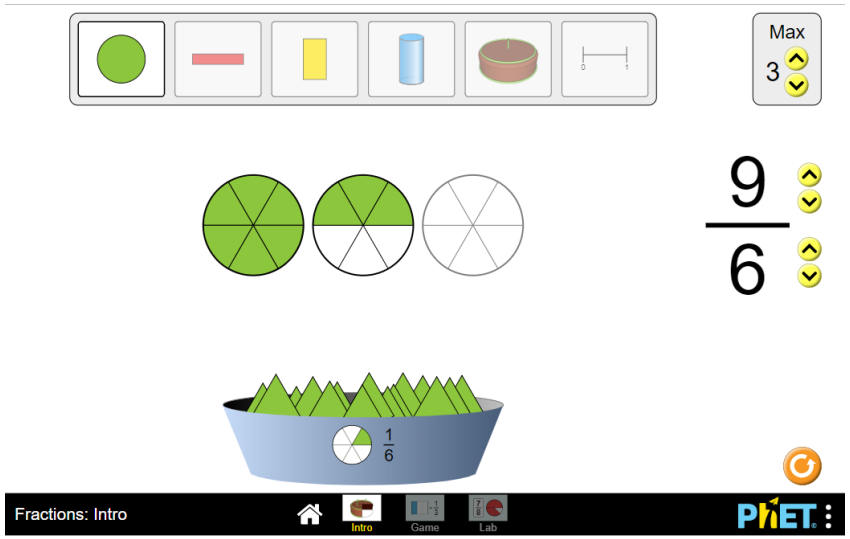
gooru

OER COMMONS
OPEN EDUCATIONAL RESOURCES

PHET IS INNOVATING IN MATH

EXISTING K12 MATH SIMS

21 math-focused sims, e.g. Fractions



Fractions Intro

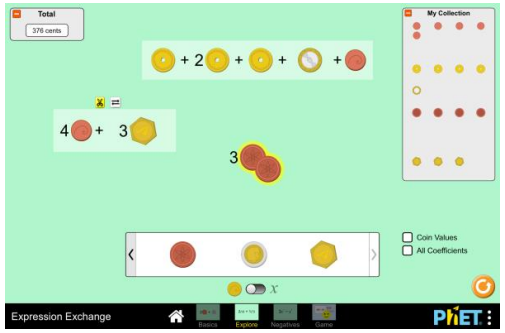
MATH EXPANSION: ALGEBRAIC THINKING

6th-9th grade focus for developing algebraic thinking

Research on design and classroom implementation

Published sims:

- Function Builder
- Unit Rates
- Expression Exchange
- Proportions Playground
- Graphing Slope-Intercept



NSF GRANT #1503510, 2015-2019: Teaching and Learning Algebraic Thinking Across the Middle Grades: A Research-based Approach Using PhET Interactive Simulations

INNOVATING IN ACCESSIBILITY

INCLUSIVE DESIGN FOR INTERACTIVE SIMULATIONS

Keyboard navigation

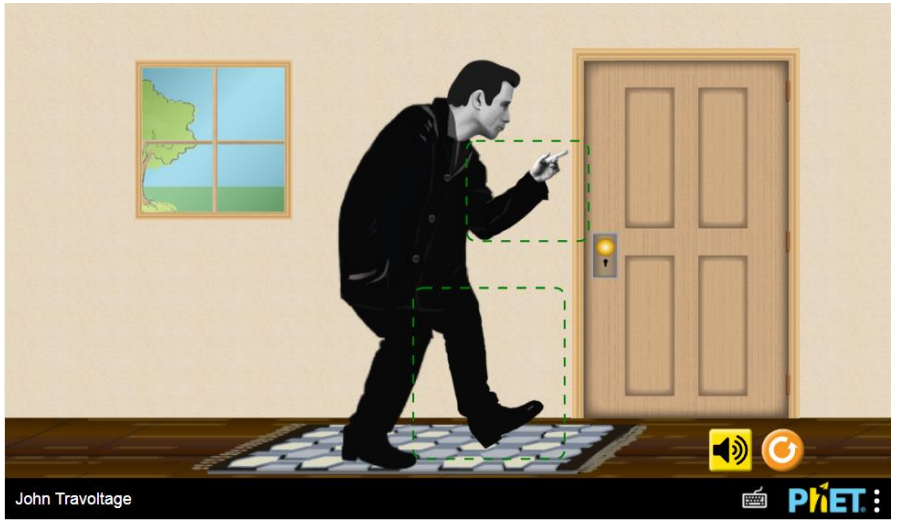
Auditory descriptions

Sonification

ENABLING EXPLORATION AND DISCOVERY FOR…

Students with cognitive disabilities

Students with physical disabilities, including low or no vision



John Travoltage: First accessible PhET simulation
Published May 2017

NSF GRANT #1503439, 2015-2017: Ramping Up Accessibility in STEM: Inclusively Designed Simulations for Diverse Learners
NSF GRANT #1621363, 2016-2019: Sonified Interactive Simulations for Accessible Middle School STEM
NSF GRANT #1621363, 2018-2021: Highly Adaptive Science Simulations for Accessible STEM Education

http://phet.colorado.edu/en/accessibility

INNOVATING IN ASSESSMENT

FORMATIVE AND SUMMATIVE ASSESSMENT

Going beyond content to measure

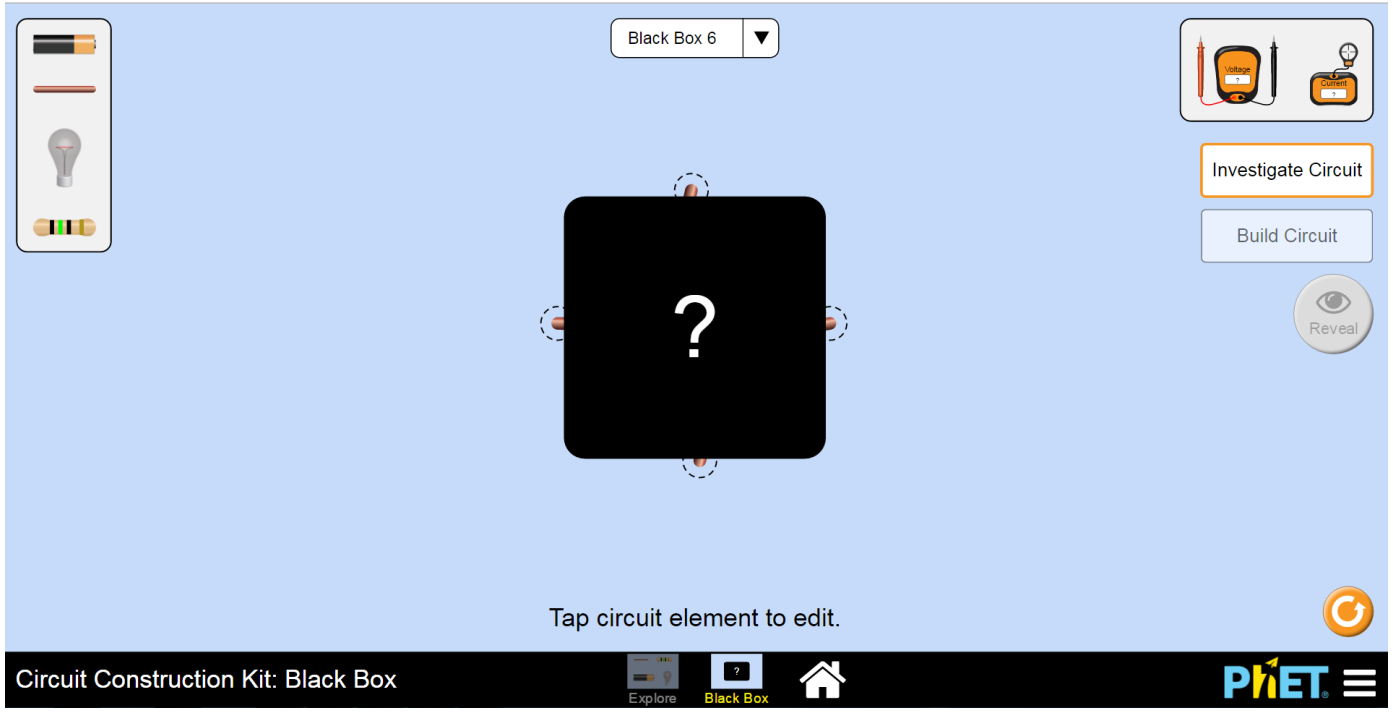
STEM practices and thinking

Problem solving strategies

Engage students in and observe

their experimentation cycle

and their reflective practices.



Example of Circuit Construction Kit: Black Box

In collaboration with Dr. Carl Wieman, Stanford University

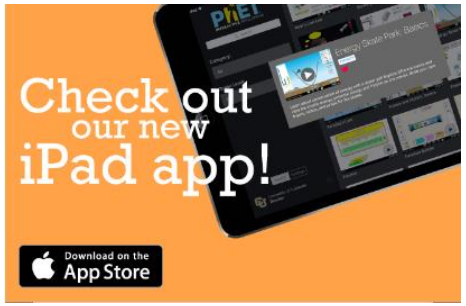
GORDON AND BETTY MOORE FOUNDATION GRANT: Pioneering Next-Generation Assessments of Science Learning

BUILDING A SUSTAINABLE BUSINESS MODEL

Paid Partnership Agreements around our free Creative Commons licensed sims:

PhET INTERACTIVE SIMULATIONS

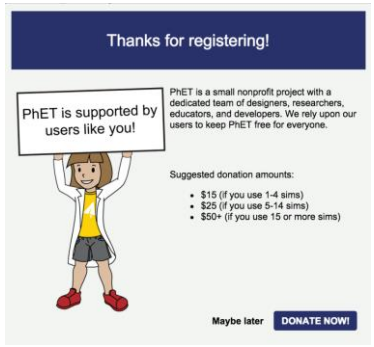
iPad and Android Apps for School and Parent Sales:



Business-to-business Licensed Products:

PhET-iO
INTERACTIVE SIMULATIONS WITH INTEROPERABLE FEATURES

Individual donations:



Examples of publications also attached ….

Chemistry Education Research and Practice

PAPER View Article Online View Journal

Check for updates

Cite this: DOI: 10.1039/c9rp00014c

South African university students' attitudes towards chemistry learning in a virtually simulated learning environment†

Mafor Penn *[a] and Umesh Ramnarain *[b]

This mixed method study investigated changes in 3rd year Bachelor of Education students' attitudes towards chemistry after learning interventions with virtual chemistry simulations. After participant students identified certain concepts from their 3rd year chemistry module as being abstract and not easily comprehensible, these concepts were facilitated during a 5 week learning intervention using PhET simulations as an alternative to traditional laboratory experimentation. In the first quantitative phase of the study, a 30-item pre-attitude test was administered to assess students' attitudes towards chemistry, followed by PhET chemistry simulation learning interventions. Thereafter, students wrote a post-attitude test. Findings of this phase revealed a significantly higher mean post-attitude test score, with students showing a positive attitude towards chemistry learning, post-intervention. The quantitative phase was followed by a qualitative phase which examined students' experiences on the use of simulations through semi-structured interviews. Findings from the qualitative phase revealed that students experienced autonomy and enjoyment during engagement with the simulations. They also perceived that their experiences in the virtually simulated environment improved their visualisation of chemistry concepts, thereby improving conceptual understanding. However, the students acknowledged that simulations cannot replicate the realism and authenticity associated with practical work in an actual laboratory. The implications of these findings are that virtual simulations provide a complementary learning tool capable of improving students' attitudes towards chemistry, and perceived by students to support their visualisation of abstract chemistry concepts. The findings of this study are particularly significant for chemistry learning at schools and universities in economically challenged countries such as South Africa where there is a shortage of well-equipped laboratories.

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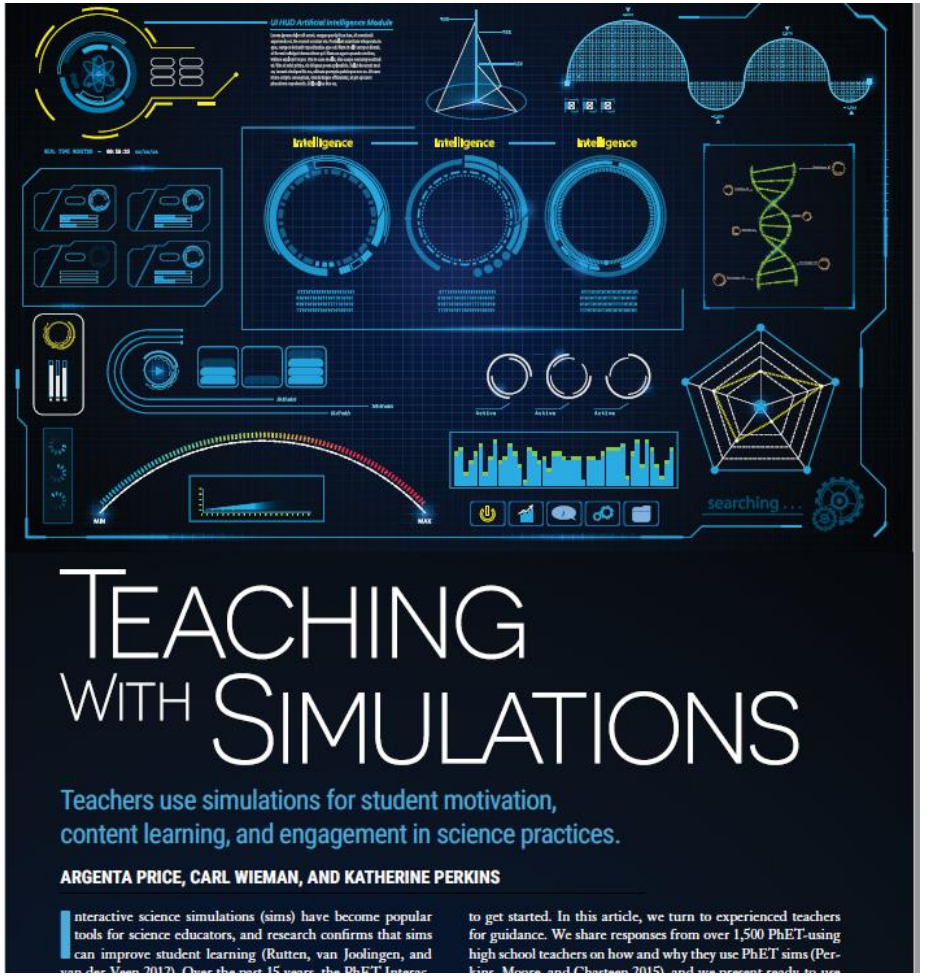
DOI: 10.1039/c9rp00014c

rsc.li/cerp

Introduction

Students' attitudes towards science and the learning of science is one of the fundamental goals of science teaching and learning (Hofstein and Mamlok-Naaman, 2011; Can and Boz, 2012). Hofstein and Mamlok-Naaman (2011) identify three key factors which can be considered to enhance students' attitudes and these include "the methods used to present the content nature of chemistry concepts, demand the incorporation of multiple tools in representing concepts, in order to enhance students' conceptual understandings. Many studies which have examined students' performance in chemistry have implicated abstraction, low imaginative power, poor concept representation and formation as some of the factors responsible for poor performance in chemistry both at high school and tertiary levels



Future work to ….

INCREASE ACCESS TO AND IMPACT OF PhET'S POWERFUL STEM LEARNING TOOLS

Fuel access and reach through the redesign and redevelopment of popular legacy sims into HTML5

Integrate effective sim-based learning into curriculum and instruction, more broadly, worldwide

Advance teacher professional development (at scale) for effective sim-based instruction

ADVANCE PHET-iO INNOVATION AND IMPACT

Use PhET-iO's advanced capabilities and backend data to advance personalized-learning environments

Use PhET-iO to advance embedded assessments and assess hard-to-measure attributes

BRING SIM-BASED INQUIRY TO MATH:

Expand efforts to support algebraic thinking development in the grades 6-10

Build a suite of 15 simulations for K-2 mathematics, focused on engaging and developing early number sense in all students

INCREASE ACCESSIBILITY FOR STUDENTS WITH LEARNING DIFFERENCES:

Advance technology, pedagogy, and research for students with diverse learning differences

Expand the suite of PhET simulations with accessibility features

600 MILLION SIMULATION RUNS (and growing)….

CONTACT:
Kathy Perkins
Kathy.Perkins@colorado.edu
303-492-6714 (work)
303-875-6840 (cell)
https://phet.colorado.edu