SRI Education

Can we enhance curriculum with cyberlearning resources?

Presented at Successful STEM Education

February 1, 2016

Jeremy Roschelle, Director
Center for Technology in Learning

The Center for Innovative Research in CyberLearning

What is cyberlearning?

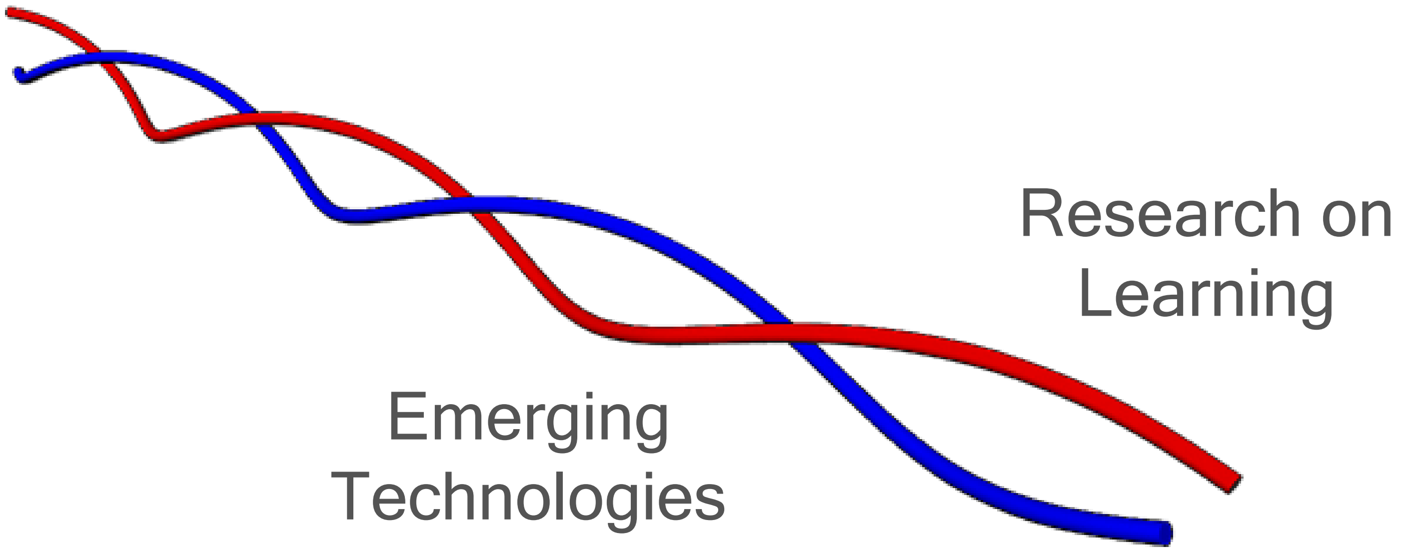
1. Jeremy Roschelle: SRI
   Overview Cyberlearning

2. Kathy Perkins, University of Colorado, Boulder
   PhET Sims

3. Jennie Chiu: University of Virginia
   Engineering and Science Practices

What is Cyberlearning?

New technologies change what and how people learn. Informed by the learning sciences, cyberlearning is the use of new technology to create effective new learning experiences that were never possible or practical before.

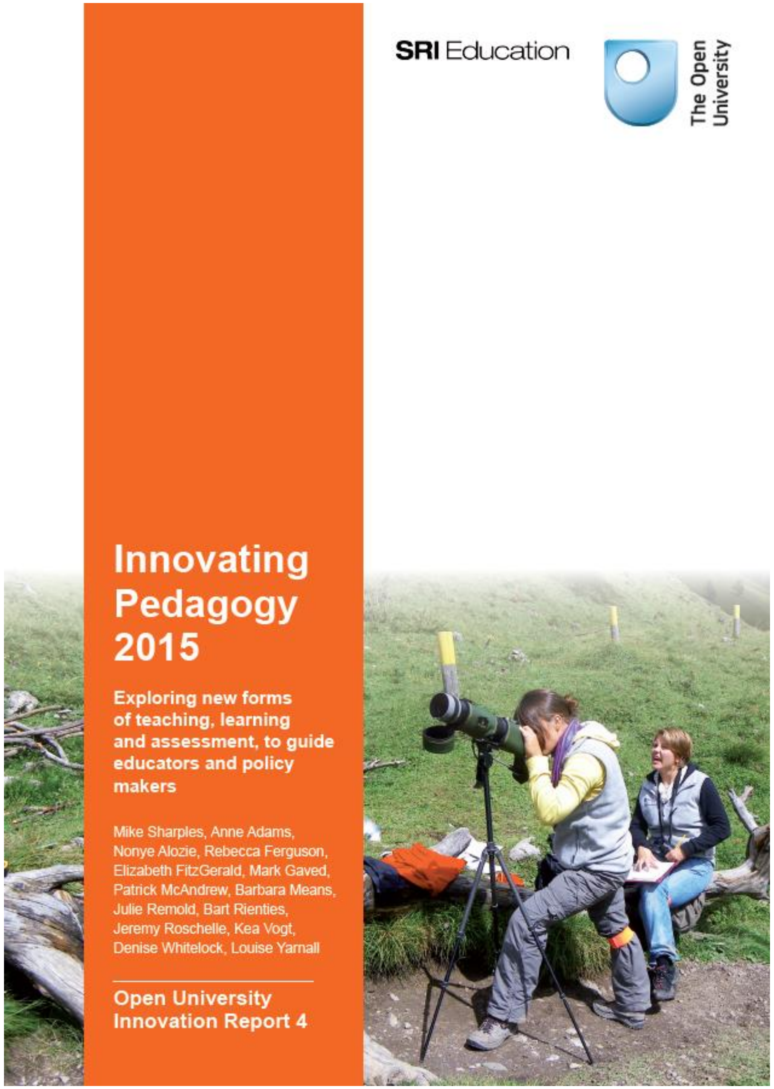


The Center for Innovative Research in CyberLearning

Represents over 200 separately funded NSF projects

CIRCLcenter.org

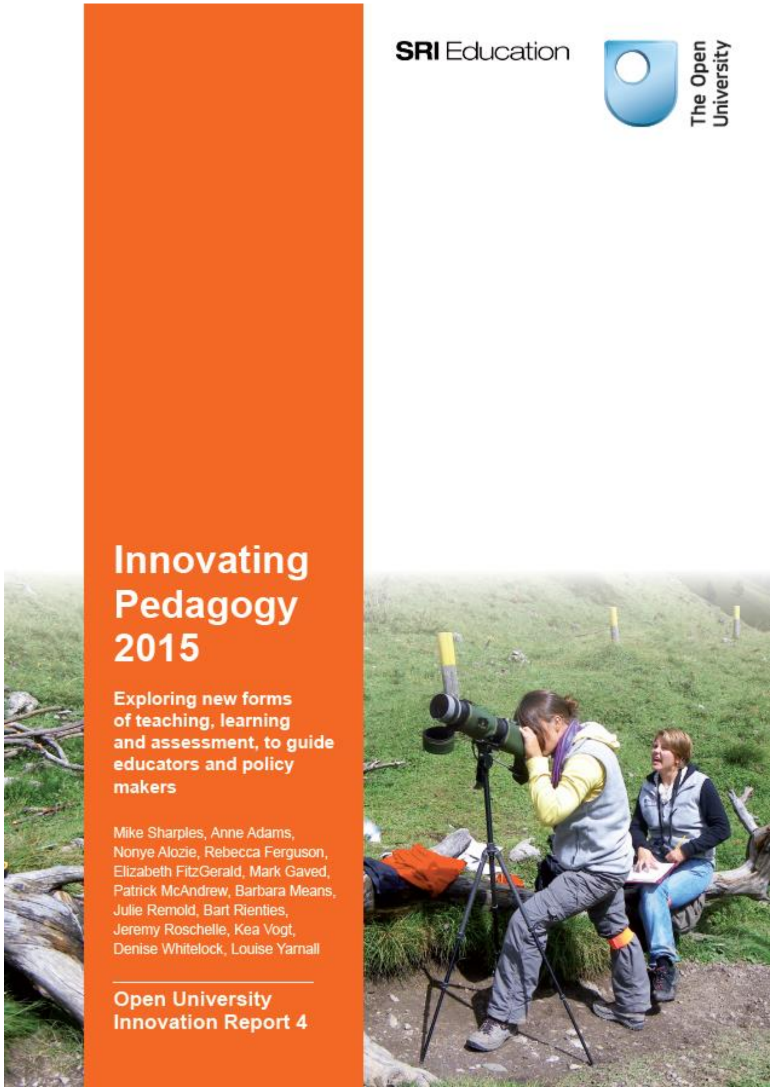
Innovating Pedagogy ’15 *(50,000 downloads!)*



Ten Pedagogies

1. Crossover Learning
2. Learning through Argumentation
3. Incidental Learning
4. Context-based Learning
5. Computational Thinking

Innovating Pedagogy ’15 *(50,000 downloads!)*



Ten Pedagogies

6. **Remote Scientific Labs**
7. Embodied Learning
8. Adaptive Teaching
9. Analytics of Emotion
10. Stealth Assessment

iLabCentral | Real Labs. Real Learning.

Radioactivity iLab

Home | Browse iLabs | News | Testimonials | About

Photocredits: www.treehugger.com

Developed By
David Chan
Chemistry Teacher/Technology Coordinator

Investigating the Safety of Nuclear Energy Using Real Radioactivity Data

STUDENT PAGE

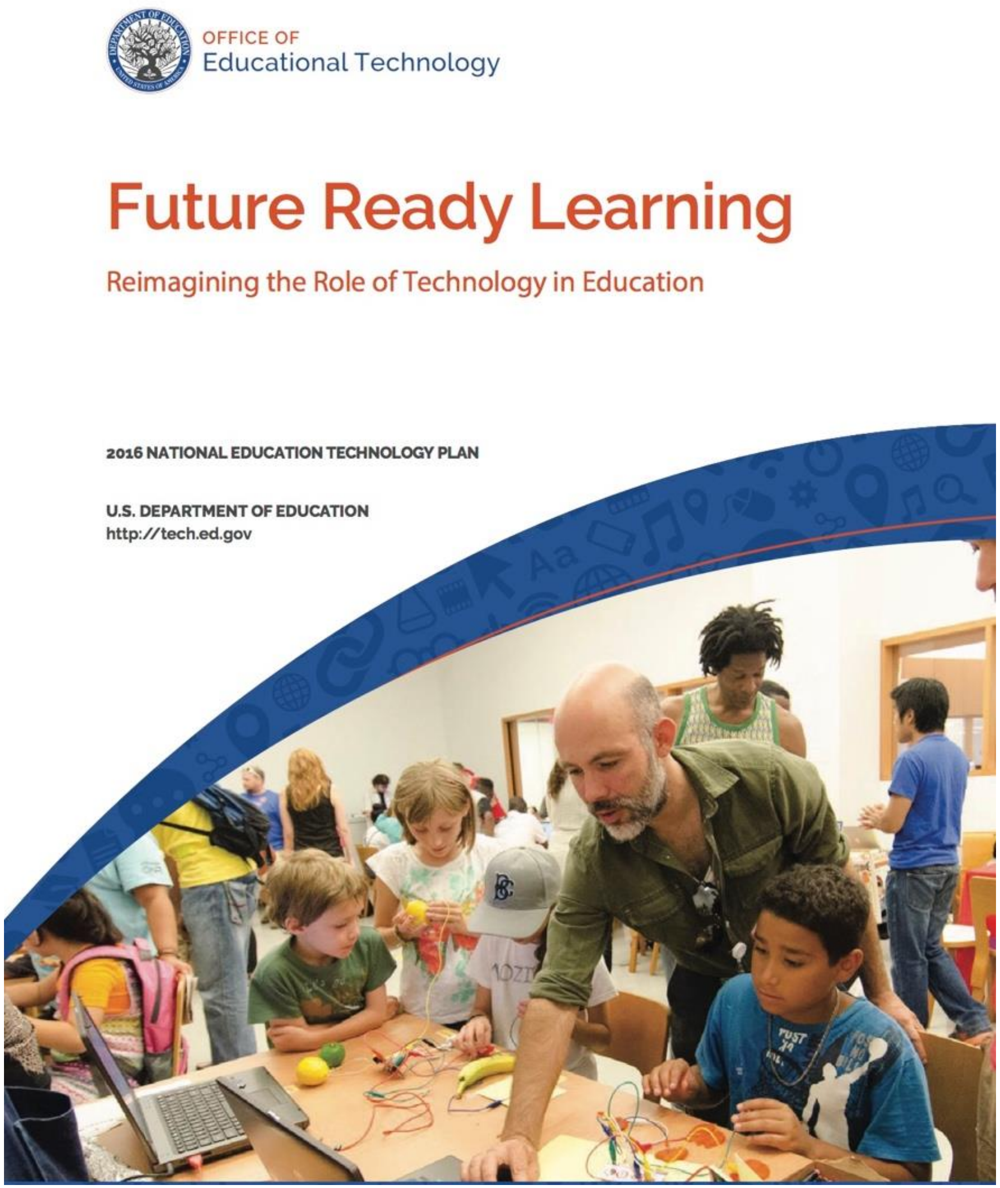
iLab: Radioactivity iLab

In this lab, you can explore how radioactive radiation changes as a function of distance. This curriculum sets the Radioactivity iLab in the context of nuclear energy, and asks you to consider:

How safe is it to live next to a nuclear reactor?

National Educational Technology Plan ‘16

Includes section on Cyberlearning (p. 16)



PhET Interactive Simulations and the NGSS

Kathy Perkins

http://phet.colorado.edu

STEM Smart Conference

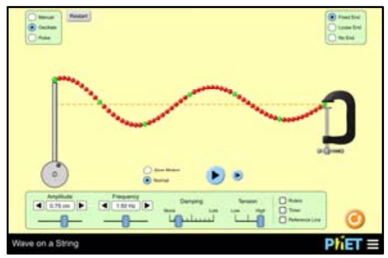
Feb 2, 2016

What is PhET?

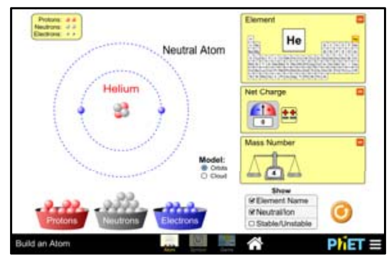
PhET INTERACTIVE SIMULATIONS
University of Colorado Boulder

- Suite of 130 **free** interactive science and math sims
- 75+ Languages
- Run online or download

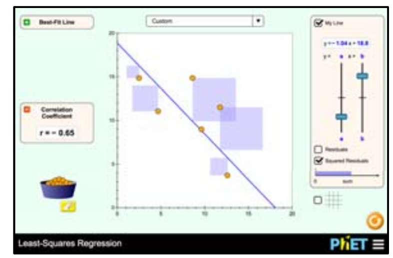
PHYSICS 93



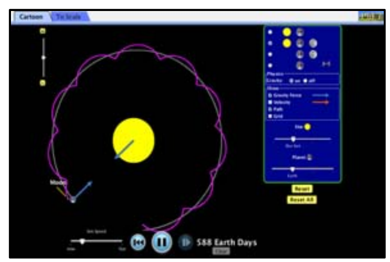
CHEMISTRY 38



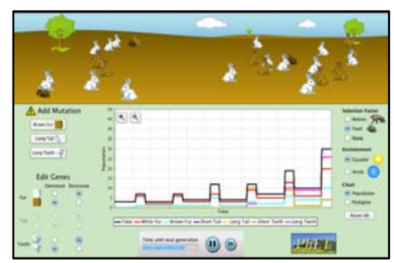
MATH 31



EARTH SCIENCE 17



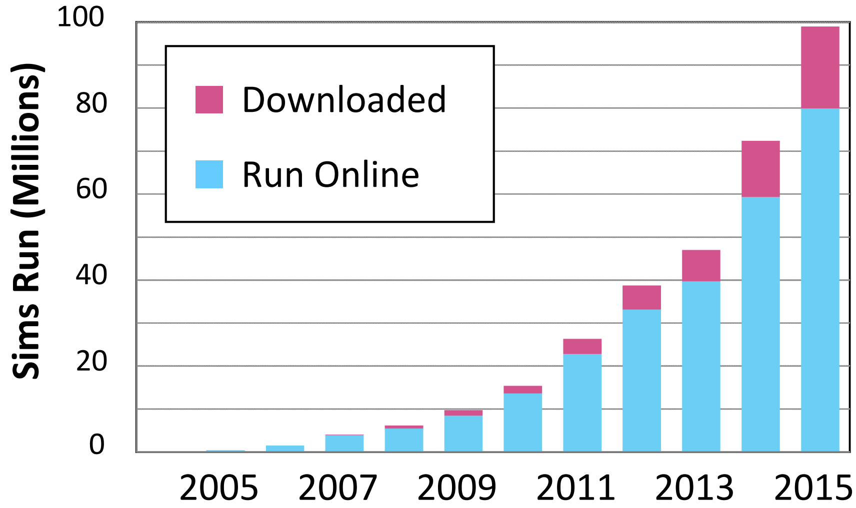
BIOLOGY 23



What is PhET?

- Suite of 130 free interactive science and math sims
- 75+ Languages
- Run online or download

SIM RUNS 2004-2015



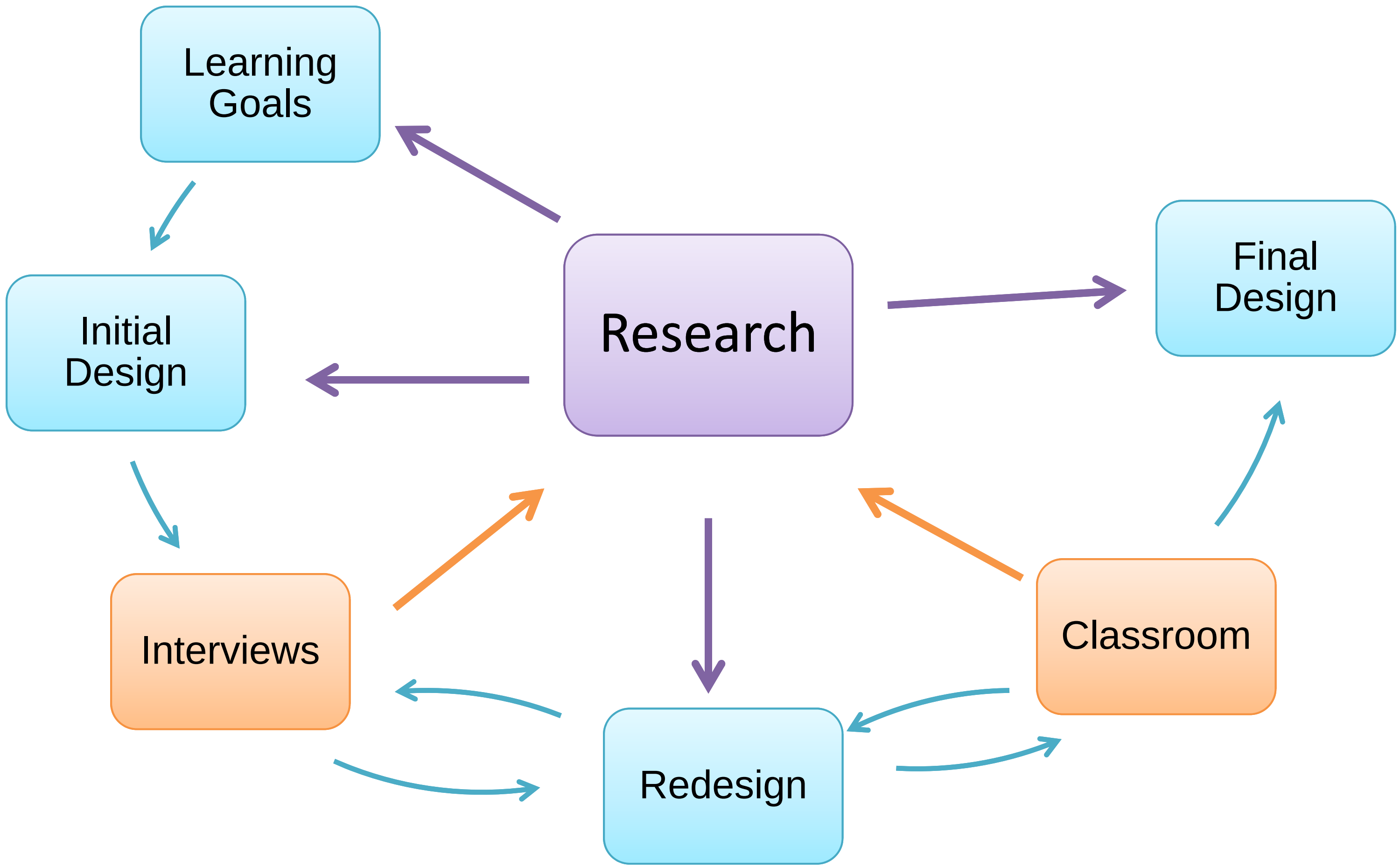
FREE at http://phet.colorado.edu

Our Goals

PhET seeks to make STEM learning more …

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

PhET is Research-Based

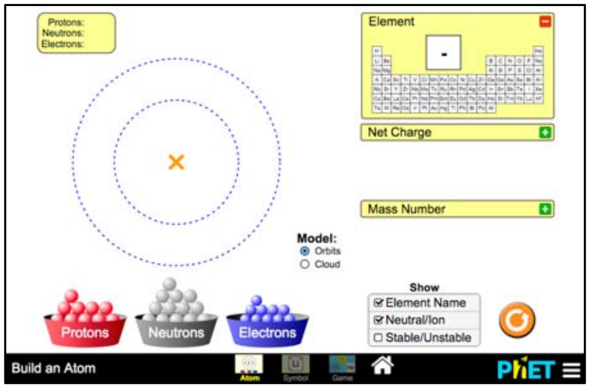


http://phet.colorado.edu/en/research

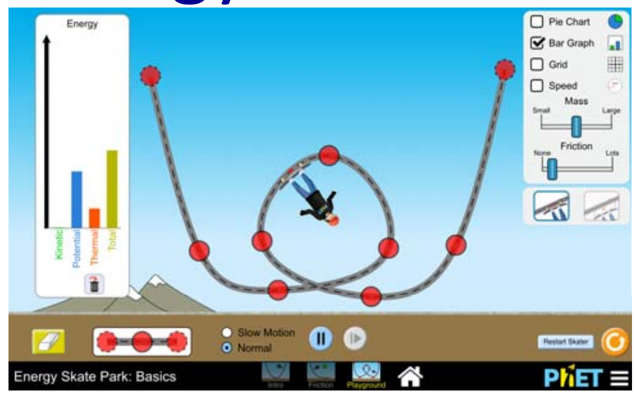
http://phet.colorado.edu/publications/phet_design_process.pdf

Sim tour

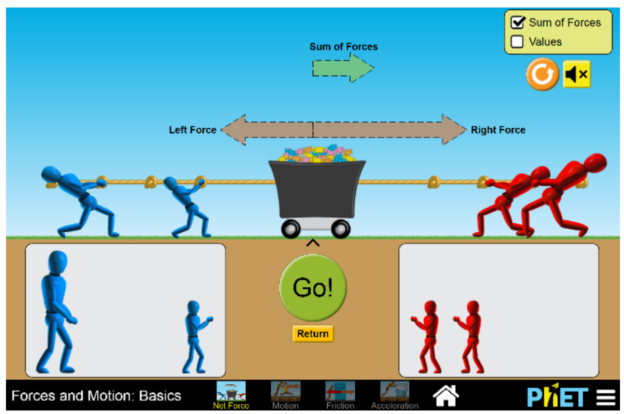
Build an Atom



Energy Skate Park



Forces and Motion



A flexible tool

Teachers use PhET sims in many ways

Lecture or lab demos

- Clicker questions
- Class discussion

Group / individual work

- In-class guided-inquiry
- Lab or pre-lab activities
- Homework

NGSS and Teaching with PhET

PhET INTERACTIVE SIMULATIONS
University of Colorado Boulder

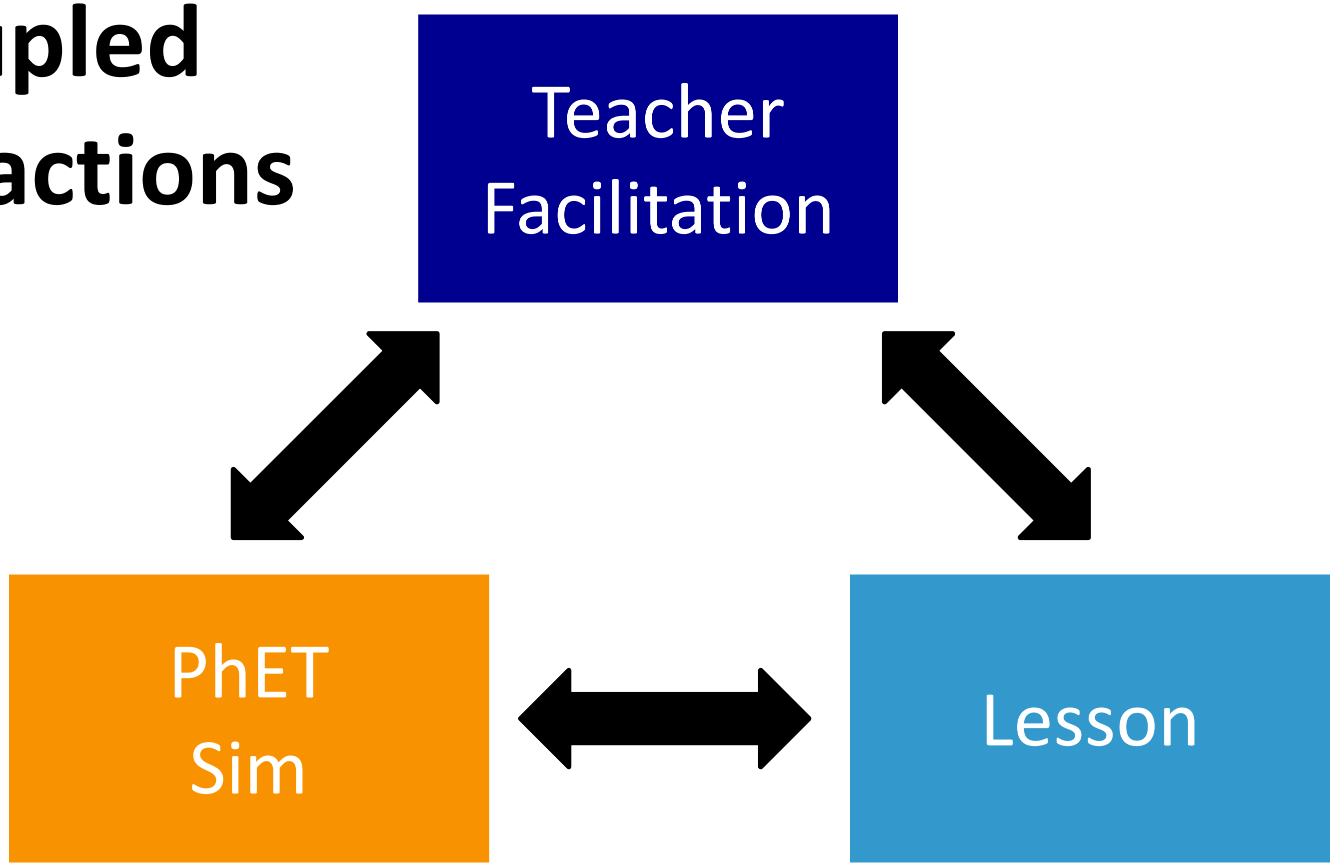
NGSS alignment involves….

PhET Sim + Lesson Design + Teacher Facilitation

… fits within the Driving Question or Problem

NGSS and Teaching with PhET

Coupled Interactions



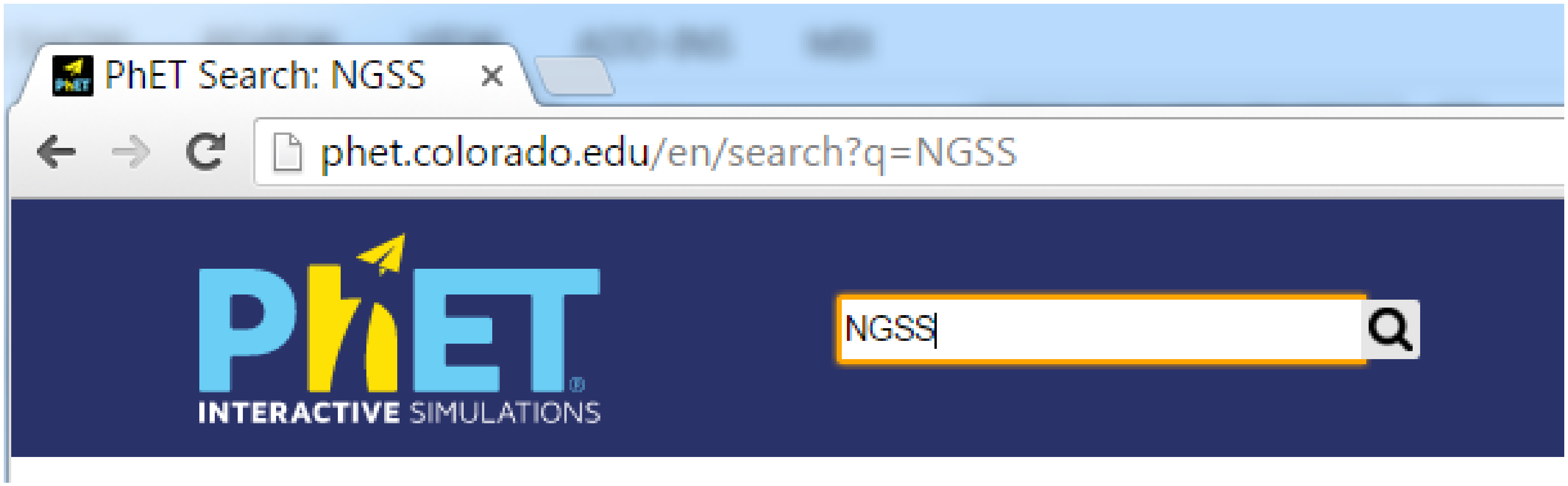
NEXT GENERATION SCIENCE STANDARDS

Science & Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts

NGSS @ NSTA

http://ngss.nsta.org

Finding PhET NGSS-Ready Sims



Alignment of PhET sims with NGSS

- HS NGSS Alignment 10-7.docx - 65 kB
- MS NGSS Alignment 10-12.docx - 65 kB

Download all files as a compressed .zip

Focus in on NGSS Practices

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. **Planning and Carrying Out Investigations**
4. **Analyzing and Interpreting Data**
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

INTERACTIVE SIMULATIONS
University of Colorado Boulder

Back

Middle School

Motion and Stability: Forces and Interactions

Show Tips

Students who demonstrate understanding can:

Performance Expectations

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. MS-PS2-2

Clarification Statement and Assessment Boundary

Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.

Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS2-2)

Connections to Nature of Science

Science Knowledge Is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2)

Disciplinary Core Ideas

PS2.A: Forces and Motion

- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

Crosscutting Concepts

Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

Back

Middle School

Energy

Show Tips

Students who demonstrate understanding can:

Performance Expectations

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. MS-PS3-1

Clarification Statement and Assessment Boundary

Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.

Assessment Boundary: none

Science and Engineering Practices

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)

Crosscutting Concepts

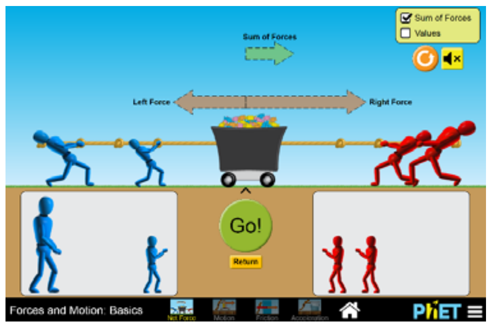
Scale, Proportion, and Quantity

- Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1)

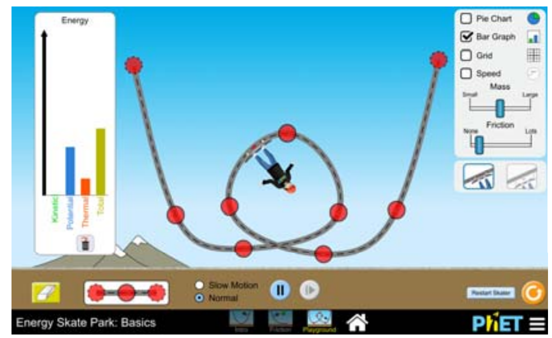
Mini-design: Prompts a practice

Think-pair-share

- Pick a sim: Forces and Motion



Energy Skate Park



- What types of questions could you use in your lesson that engages students in a science practice?

Mini-design: Prompts a practice

Examples

Explore the skater's motion, and her potential energy and kinetic energy. What do you notice?

Design an experiment to determine …

Provide evidence from the sim to defend your claim ….

Teacher Resources

Simulations
- Teaching Resources
  - Tips for Using PhET
  - Browse Activities
  - Share your Activities
  - My Activities
  - Workshops
- How to Run Simulations
- Troubleshooting
- FAQs
- For Translators
- Donate
- Research
- Licensing
- About PhET

Tips for Using PhET

PhET simulations are very flexible tools that can be used in many ways. Here, you will find videos and resources for learning about effective ways of integrating PhET simulations into your class.

A Brief Introduction to PhET:

An overview of the PhET Simulations (Download Video)

Tips and Resources for Teaching with PhET

- Planning to Use PhET
- Using PhET in Lecture: An Overview
- Interactive Lecture Demonstrations
- Using PhET with Clickers
- Designing PhET Activities for the K12 Classroom
- Facilitating PhET Activities for the K12 Classroom
- Take a Virtual PhET Workshop

Guidance for using particular simulations:

- Browse our activities for use with each simulation
- Find teacher tips for use with specific simulations on individual simulation pages (where applicable)

Tips and Resources


Planning to Use PhET


Using PhET in Lecture: An Overview


Interactive Lecture Demonstrations


Using PhET with Clickers


Designing Activities for K12


Facilitating Activities for K12


Take a Virtual PhET Workshop

Next Generation PhET

- Coming soon in HTML5

Pendulum Lab	Charges & Fields	Neuron
States of Matter	Masses and Springs	Trig Tour

- More teacher resources
  - Video primers for sims
  - Updated Tips for Teachers

- Accessibly designed sims
  - Keyboard Navigable
  - Screen Reader Compatible
  - Sonification

PhET is free thanks to our sponsors

PhET INTERACTIVE SIMULATIONS
University of Colorado Boulder

NSF

THE WILLIAM AND FLORA HEWLETT FOUNDATION

GORDON AND BETTY MOORE FOUNDATION

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King Saud University

PhET is supported by users like you!

WISE and WISEngineering Connections Between NGSS Content and Practices

Jennifer Chiu
jlchiu@virginina.edu

STEM Smart workshops are funded by the National Science Foundation grant #1449550. Any opinions, findings, and conclusions or recommendations at this event or in these materials are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Goals

- Provide technology-enhanced 3D NGSS curricular resources to help connect practices with content
- Combine curricula, assessment, teacher tools
- Engineering DCIs and practices

Can we enhance our curriculum with cyberlearning resources? **YES**

Design Challenge

- Create a school garden
- Must grow some edible plants and be student maintained
- Total space = 20' x 20'
- Total budget = $400
- Total time = 2 weeks

What would your next steps be?

NGSS Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Making NGSS Connections

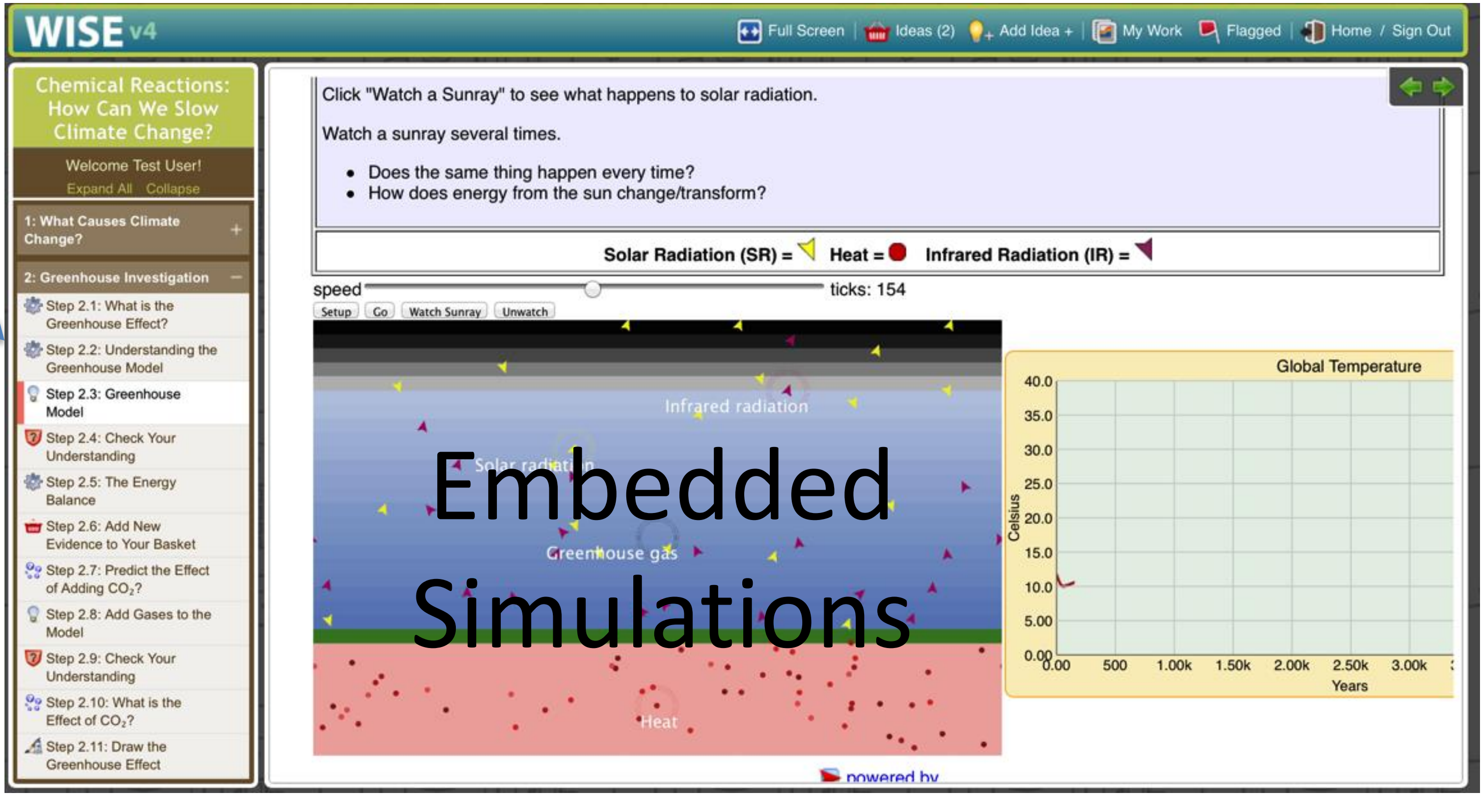
WISE: Web-based Inquiry Science Environment:

https://wise.berkeley.edu

Supporting NGSS practices

Features to support NGSS DCI's and CC's

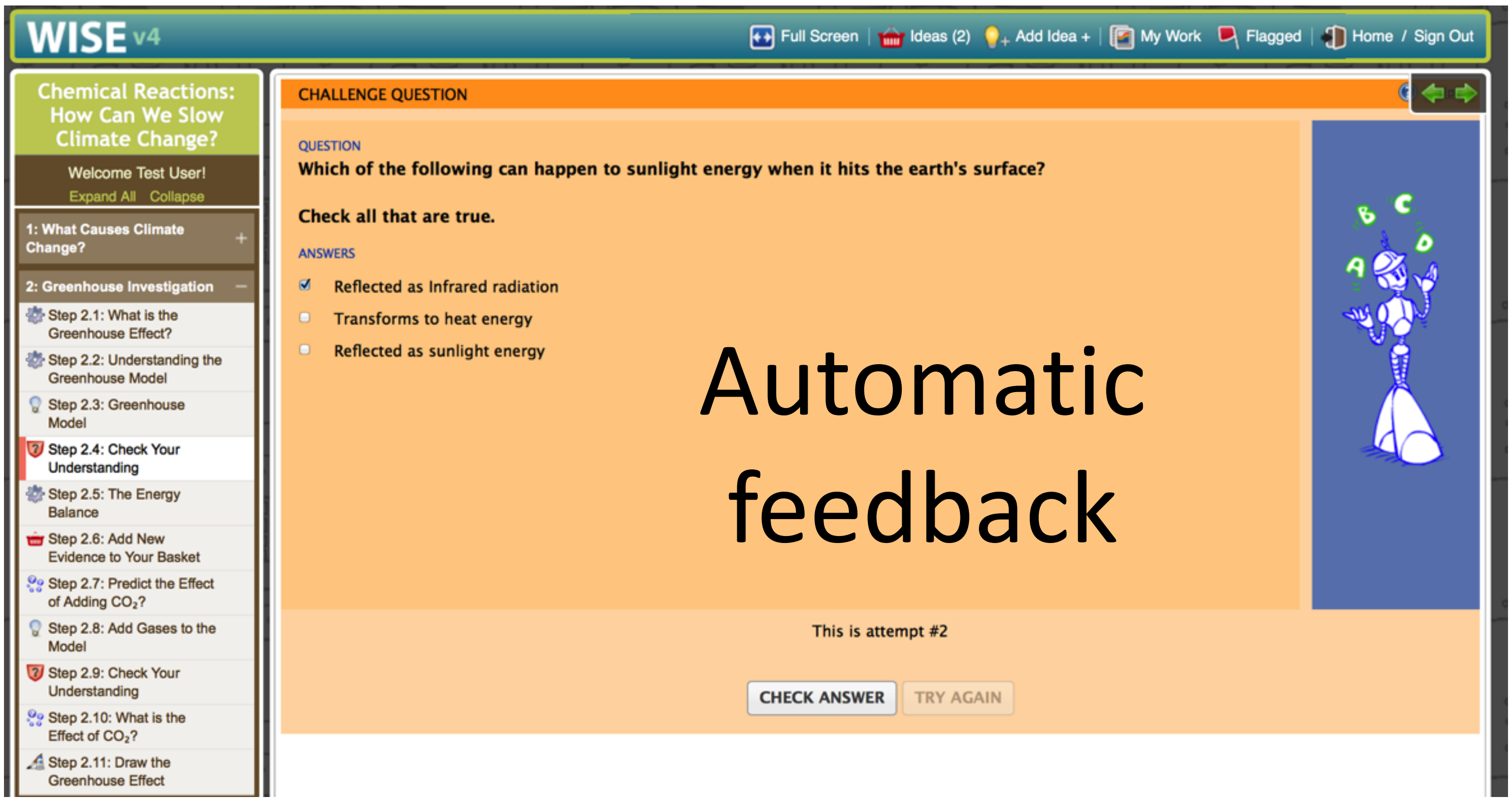
Inquiry Map



Embedded Simulations

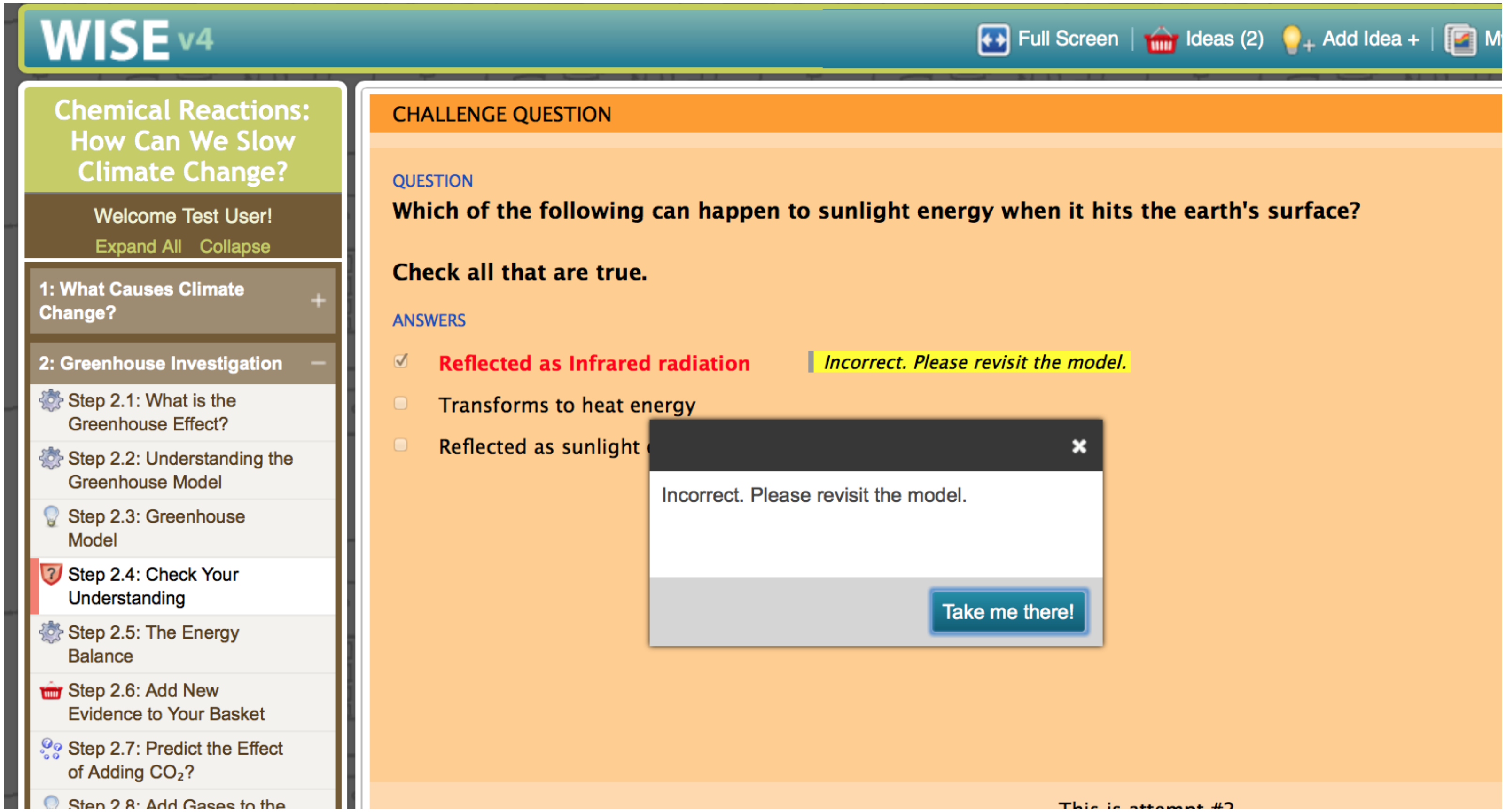
WISE

Features to support NGSS DCI's and CC's



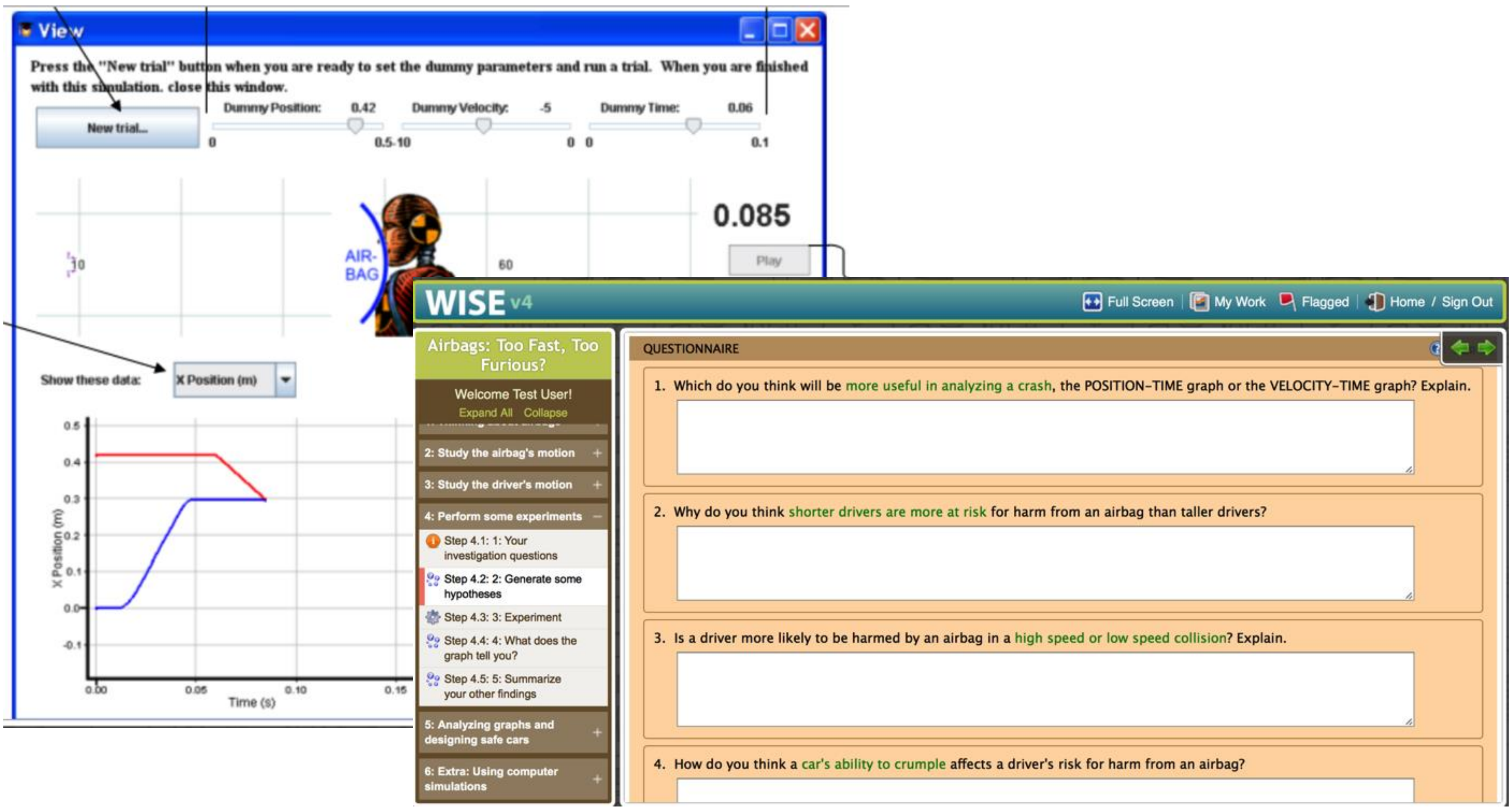
Automatic feedback

Features to support NGSS DCI's and CC's



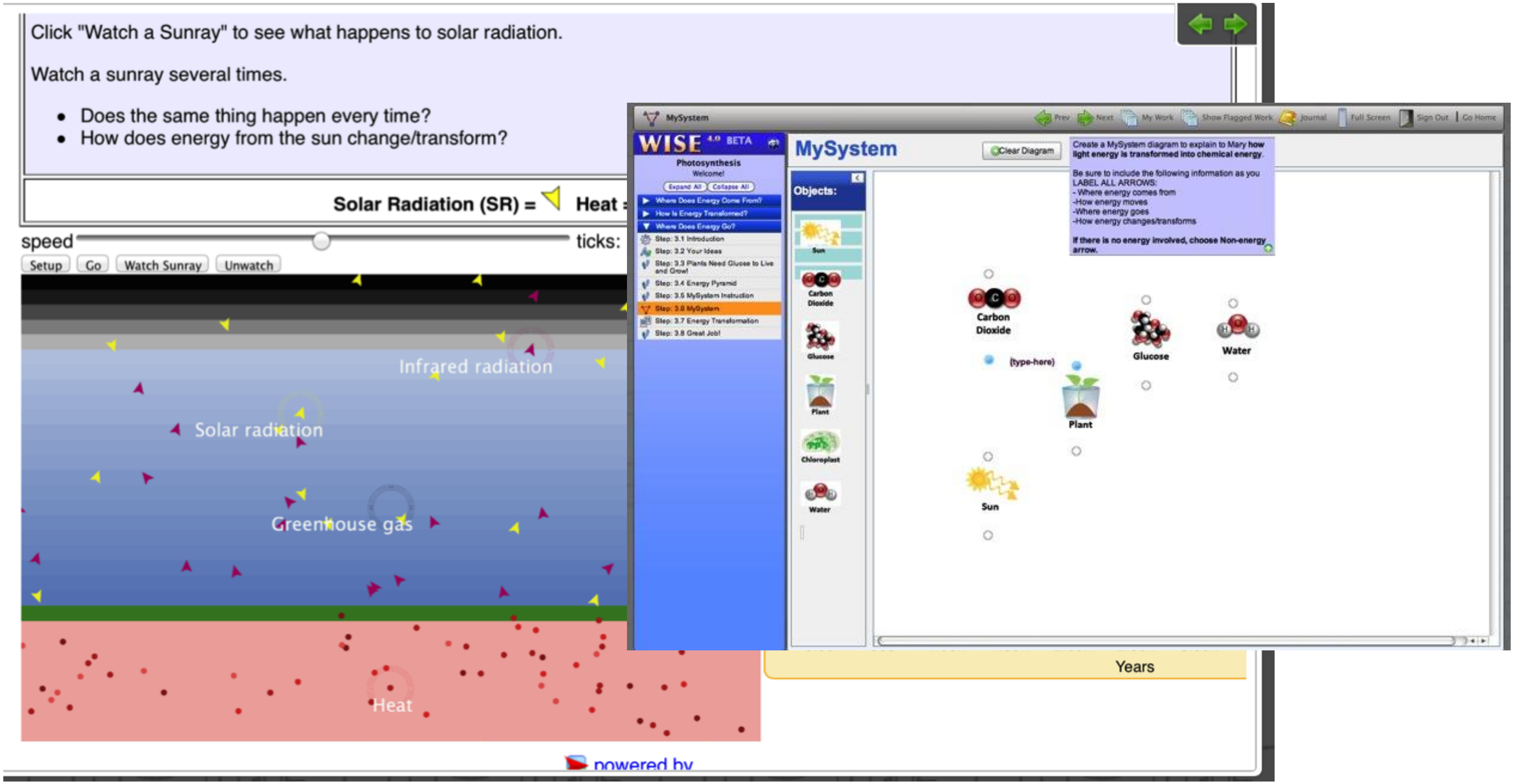
Supporting NGSS practices

Asking questions

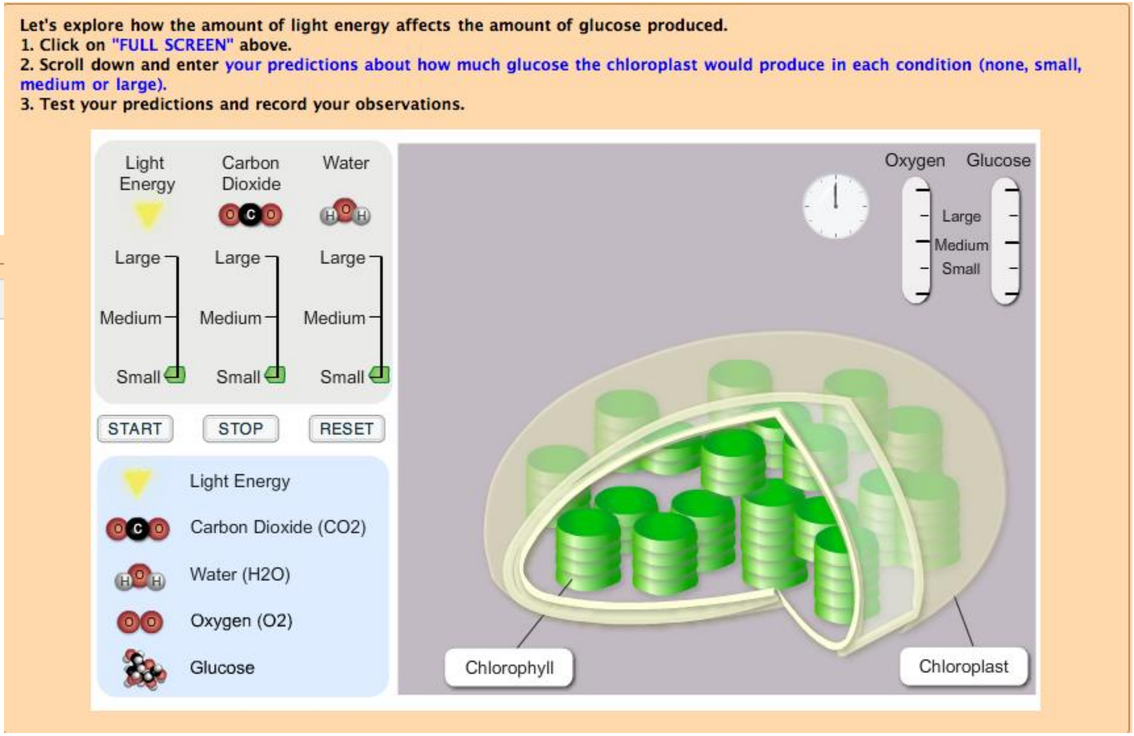


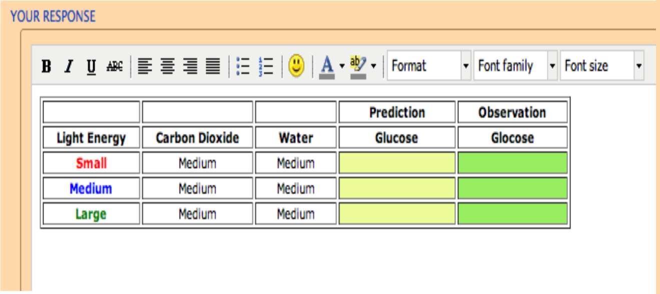
Supporting NGSS practices

Developing and using models



Planning and Carrying out Investigations

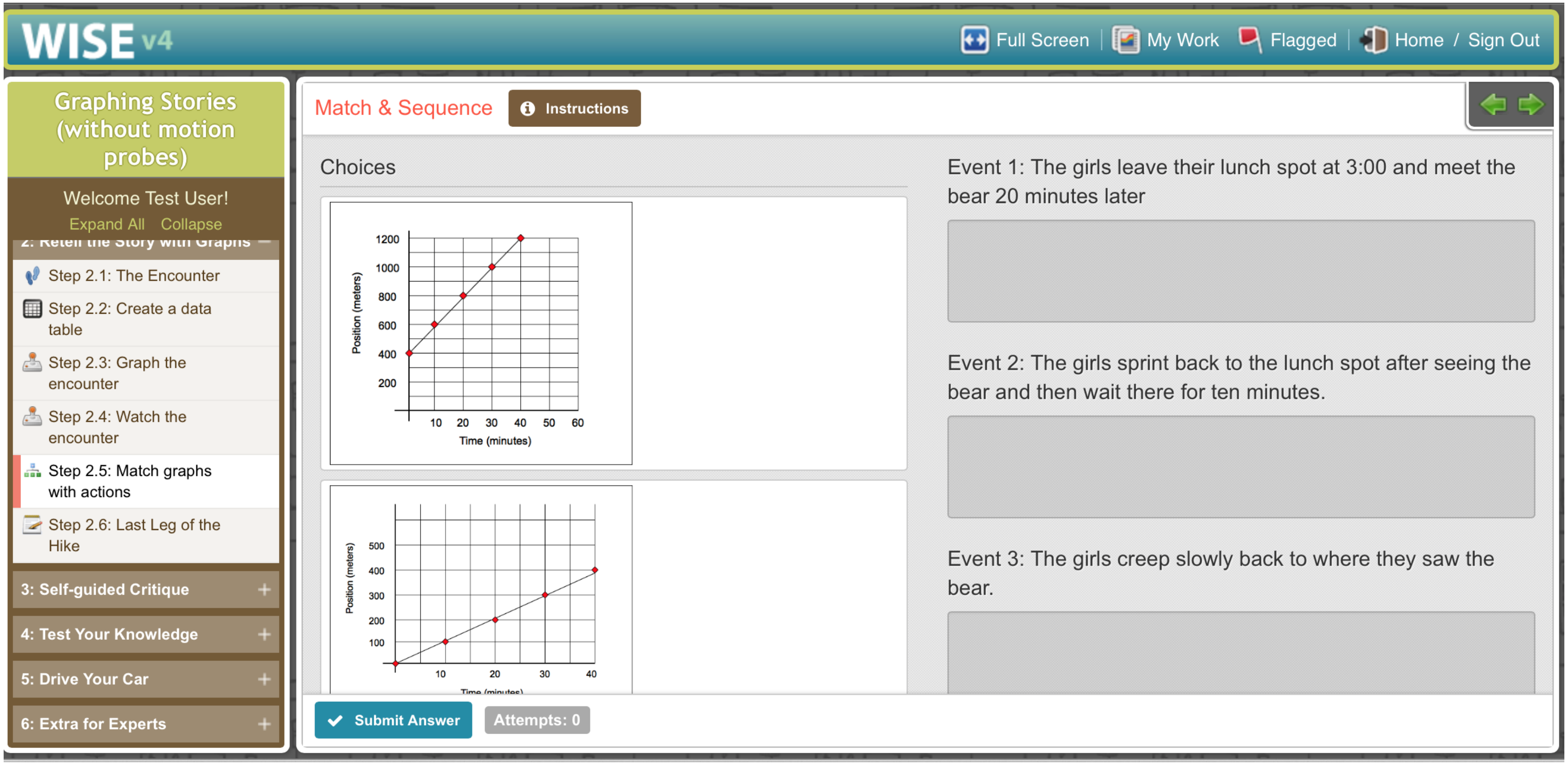



YOUR RESPONSE

			Prediction	Observation
Light Energy	Carbon Dioxide	Water	Glucose	Glocose
Small	Medium	Medium		
Medium	Medium	Medium		
Large	Medium	Medium		

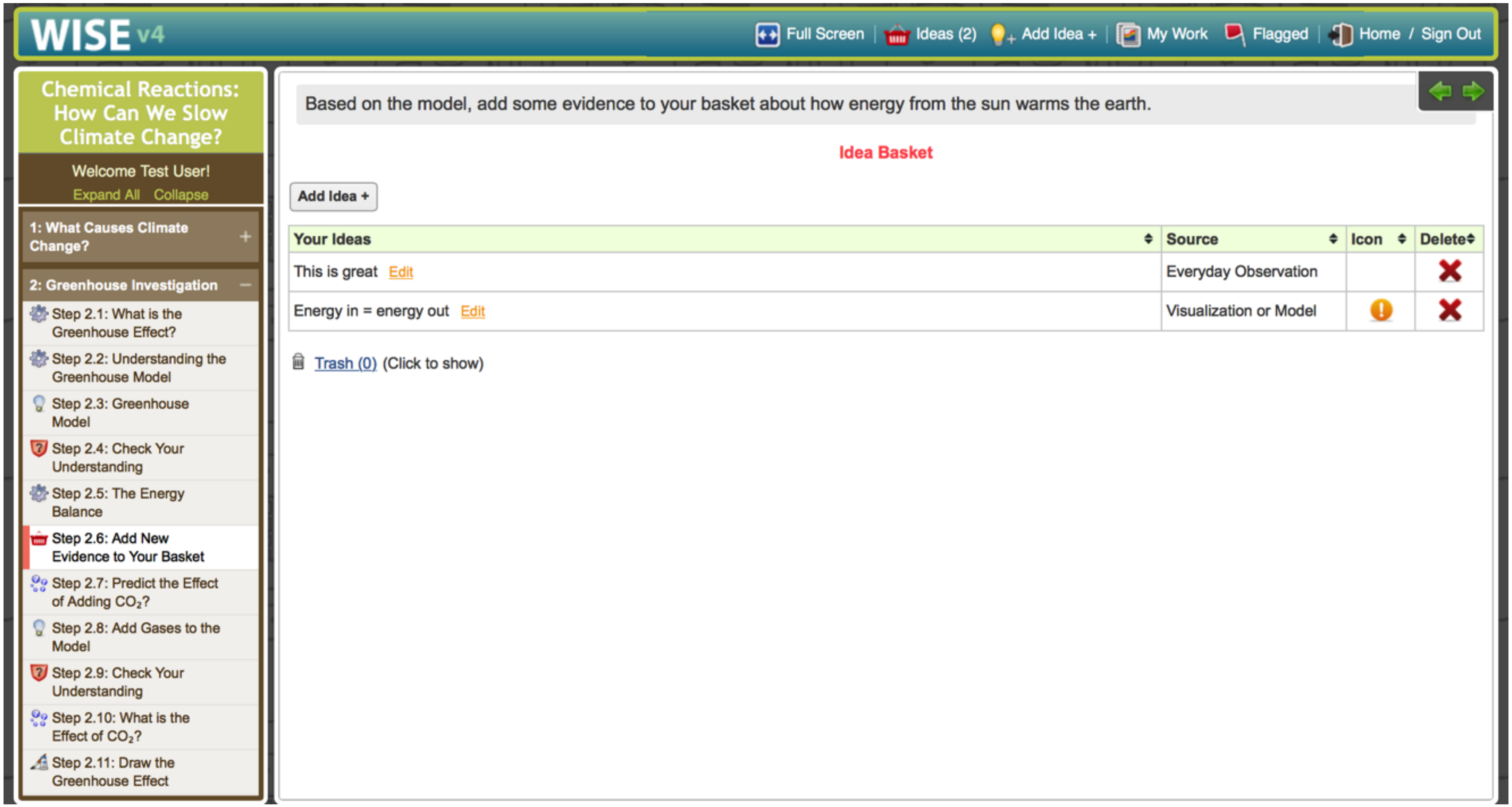
Supporting NGSS practices

Analyzing and Interpreting Data



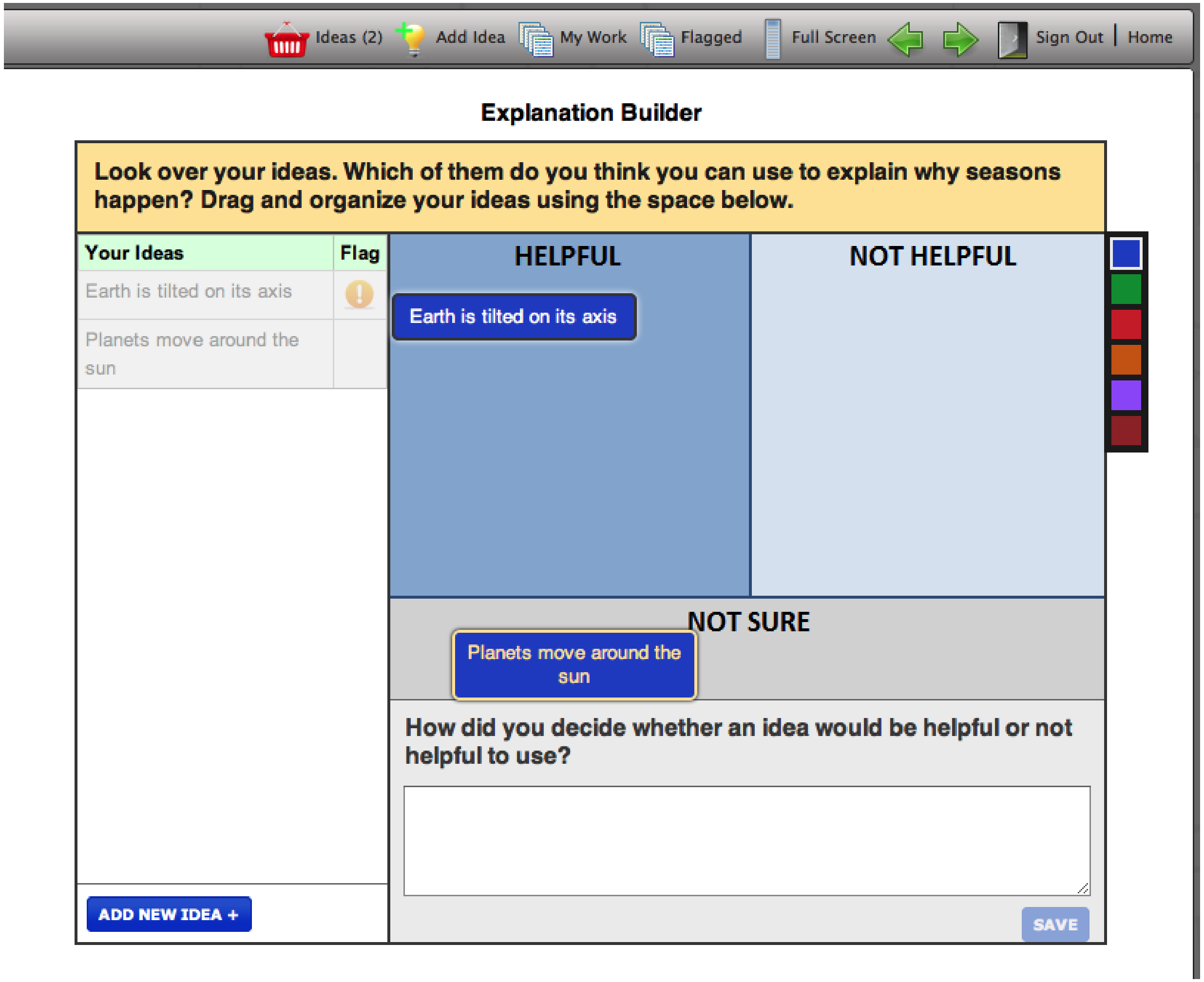
Supporting NGSS practices

Constructing Explanations

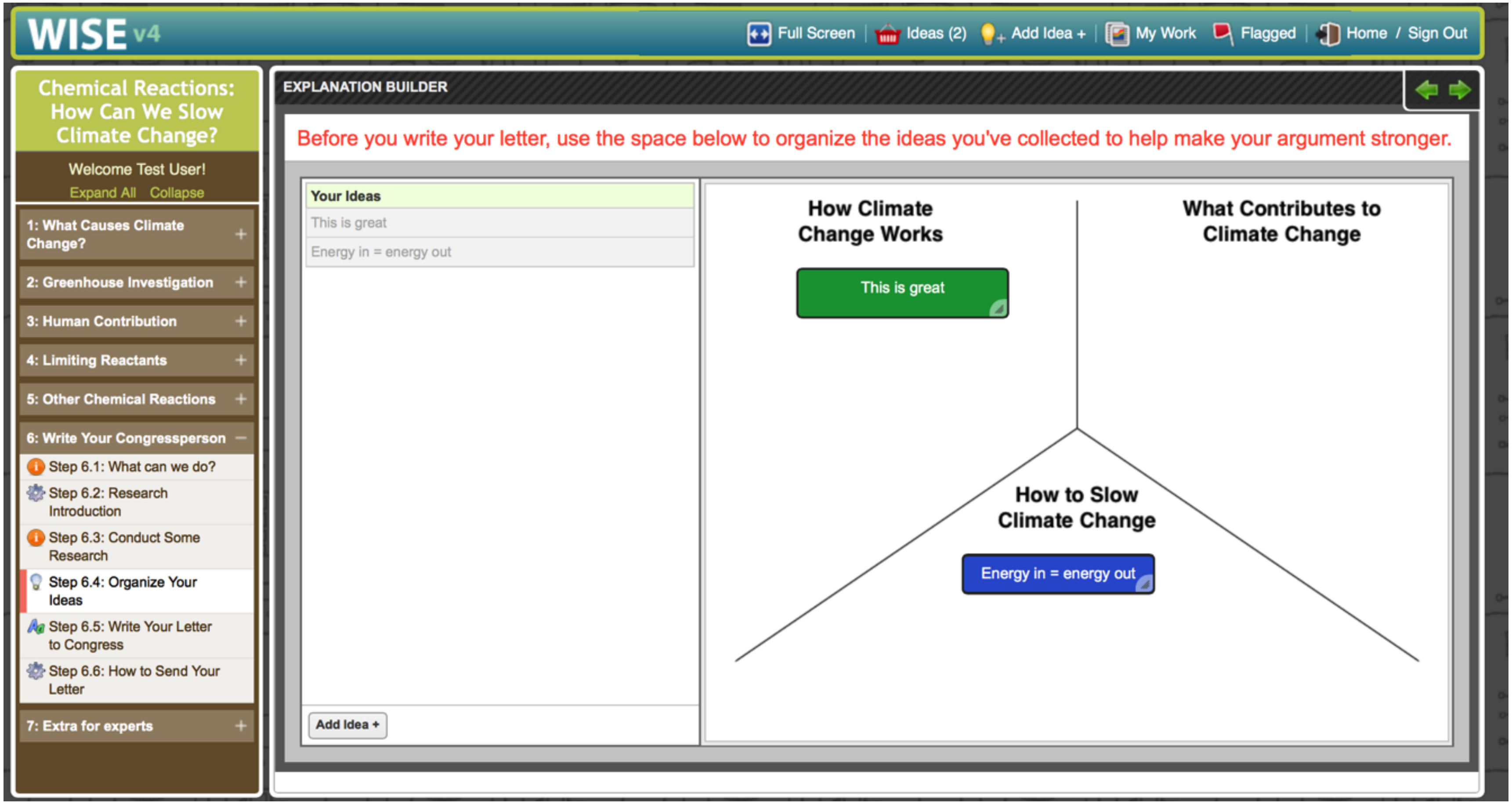


Supporting NGSS practices

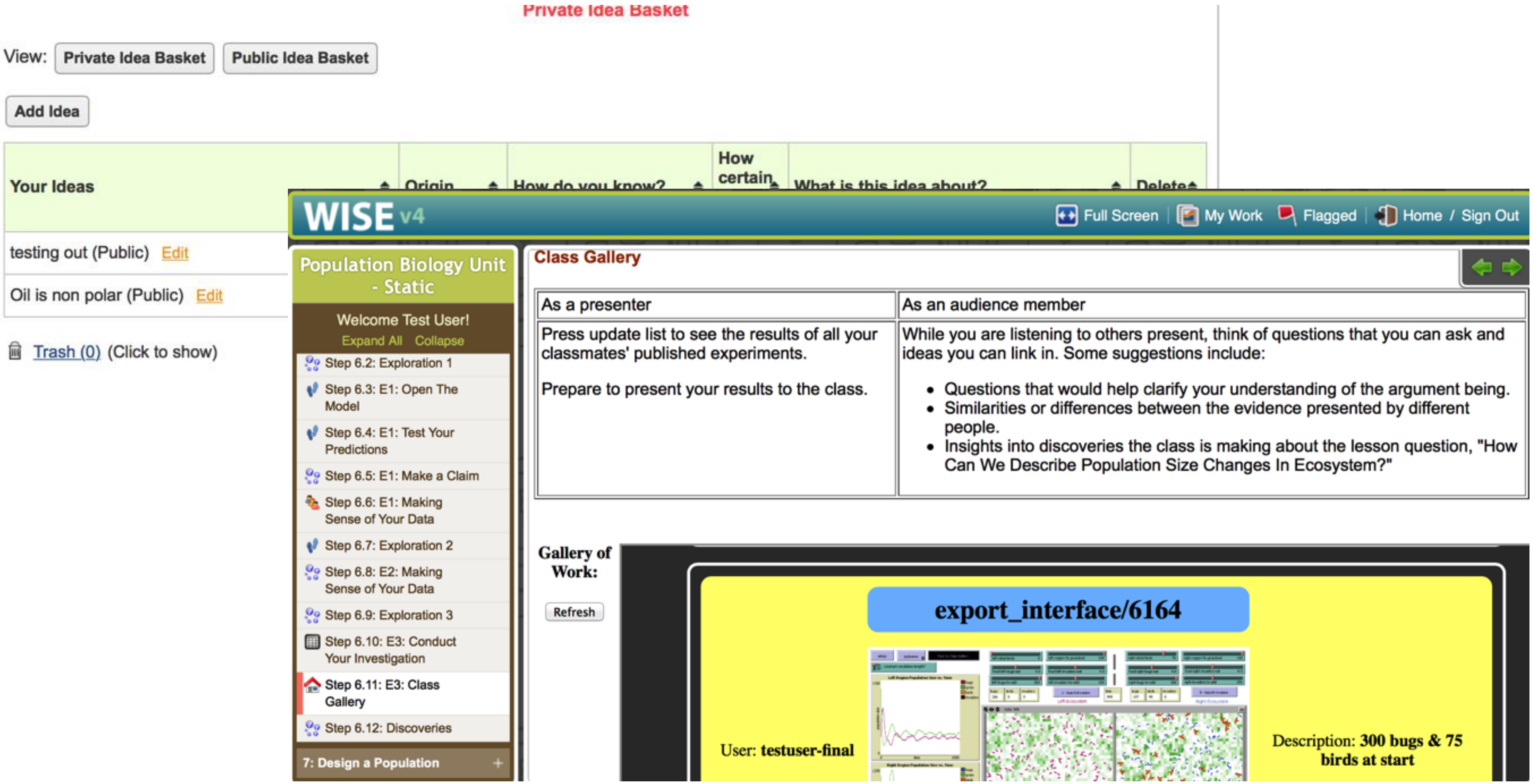
Constructing Explanations



Engaging in argument from evidence

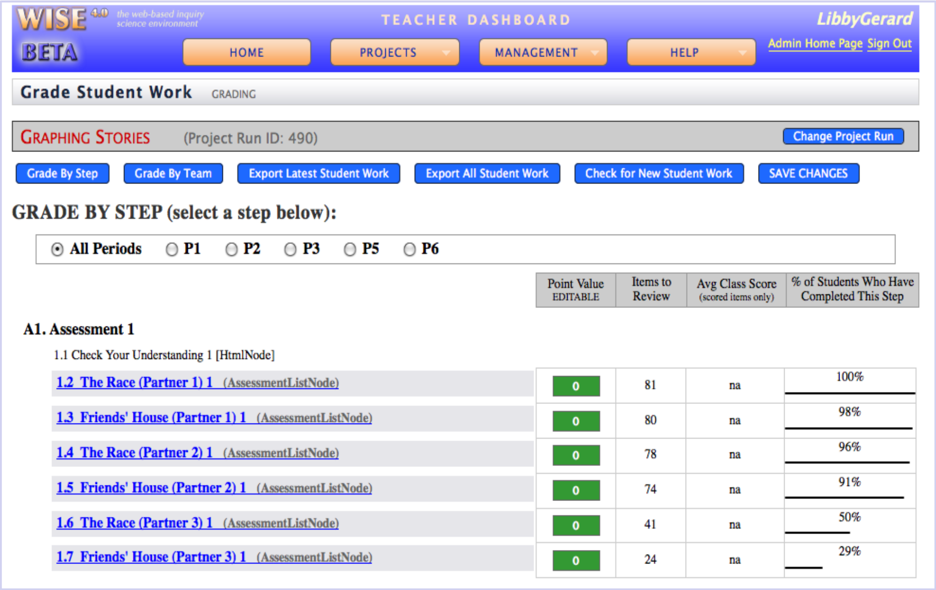


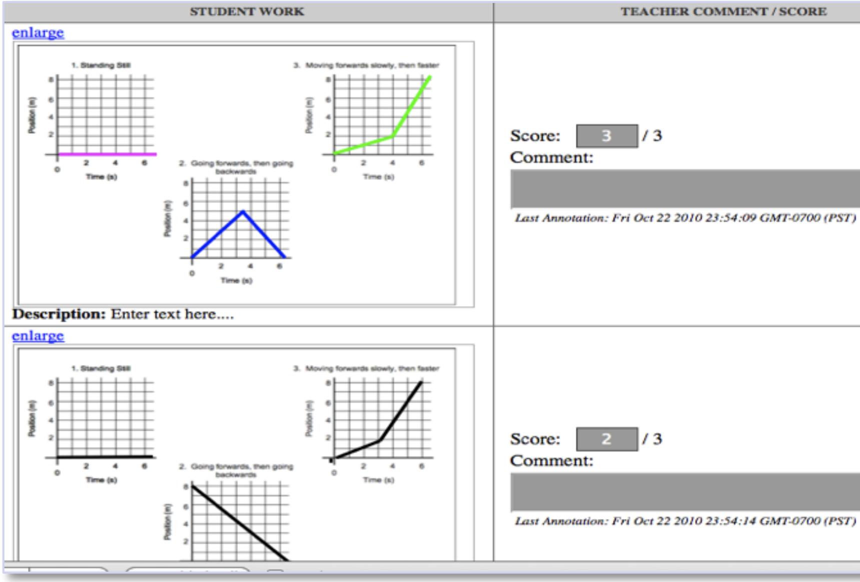
Obtaining, evaluating, communicating



Teacher Supports

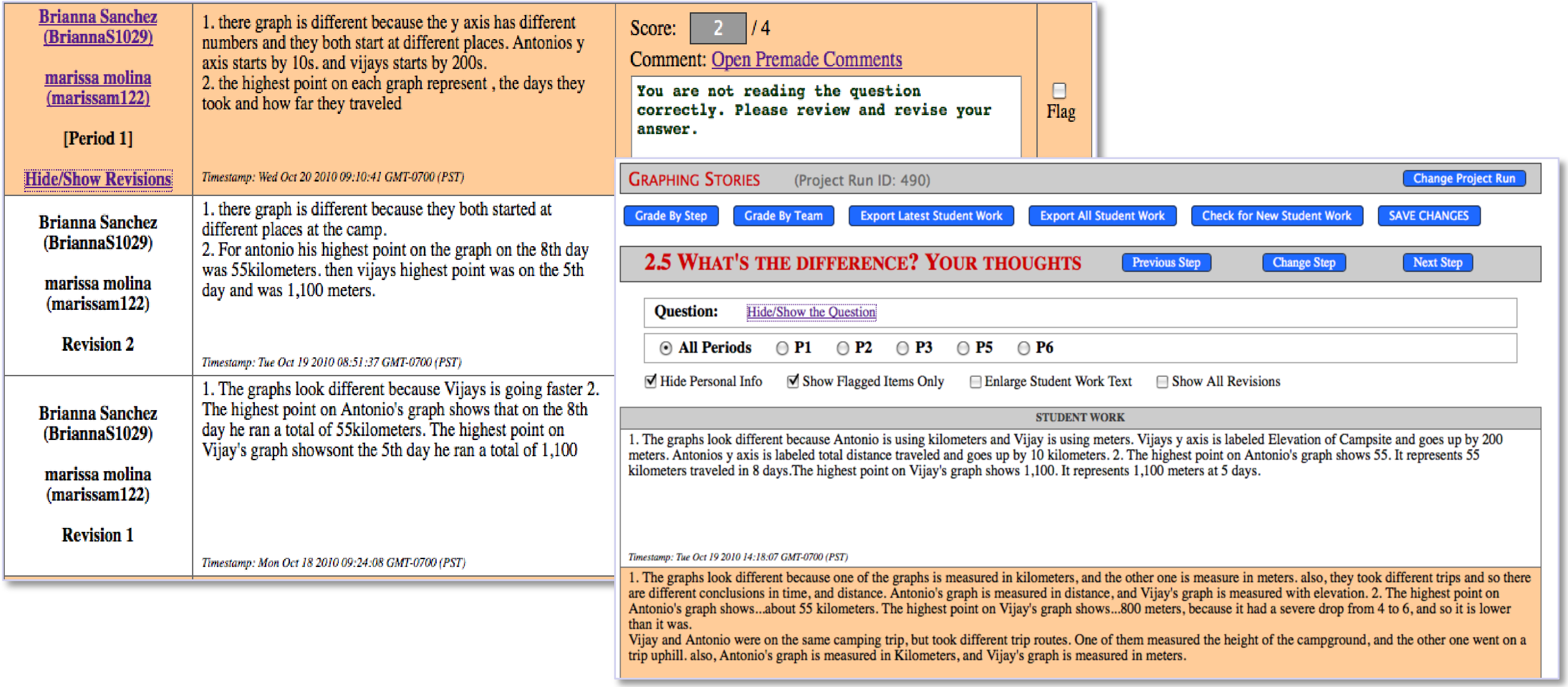
- Student Monitors/progress
- Automatic scoring of student work





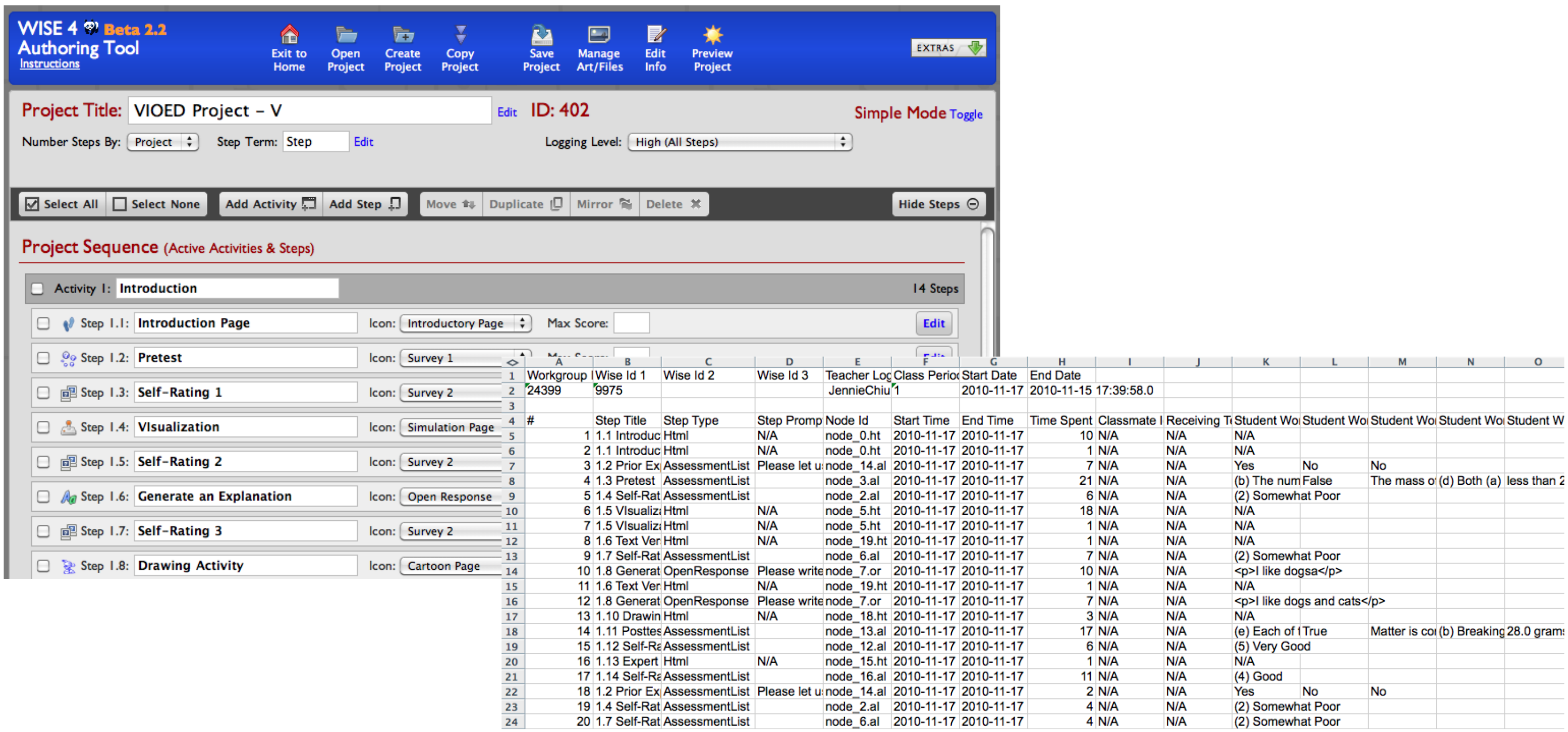
Features to support teachers

- Scoring of student work
- Feedback/displaying student work



Customization

- Authoring and research tools

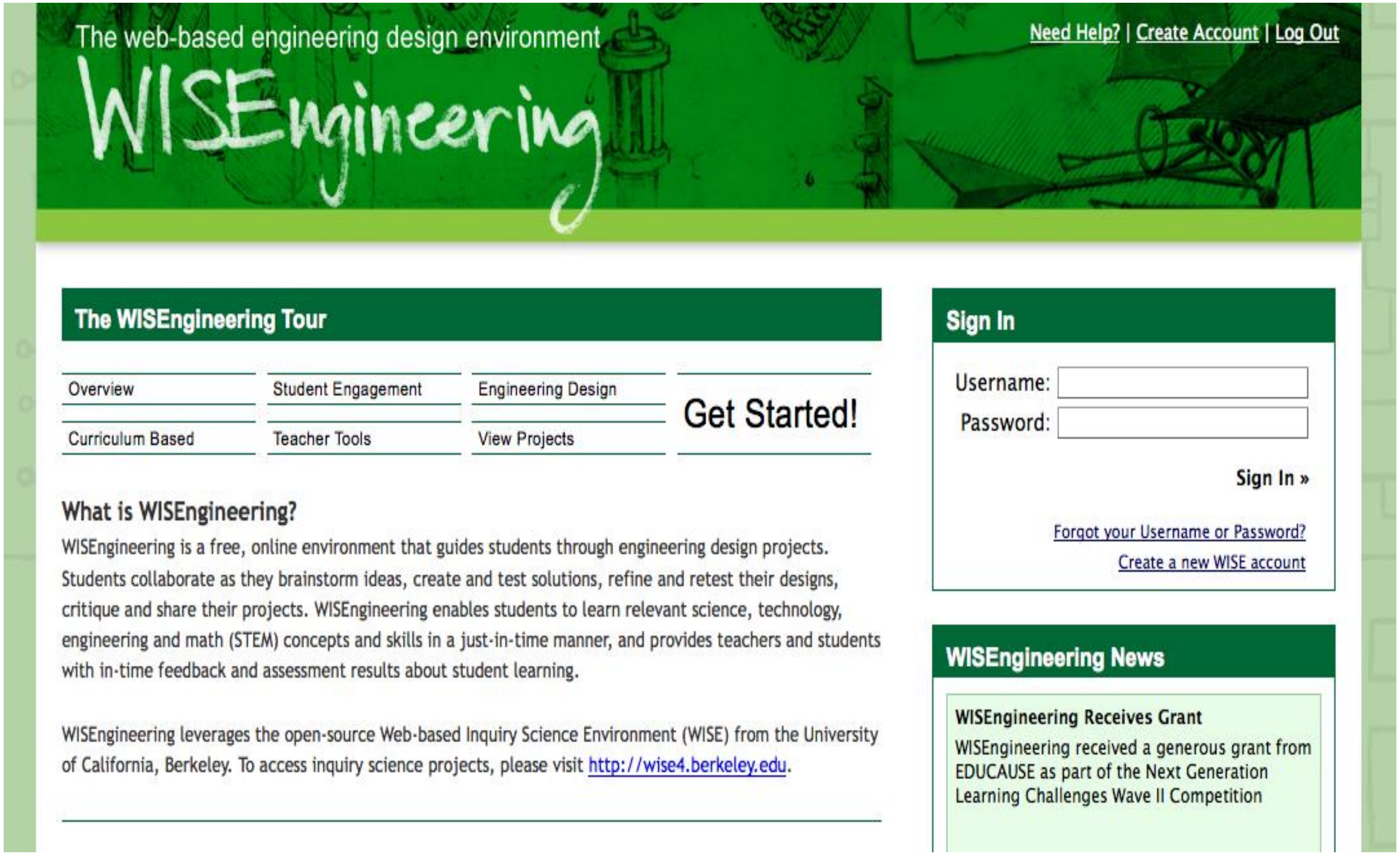


Wait…

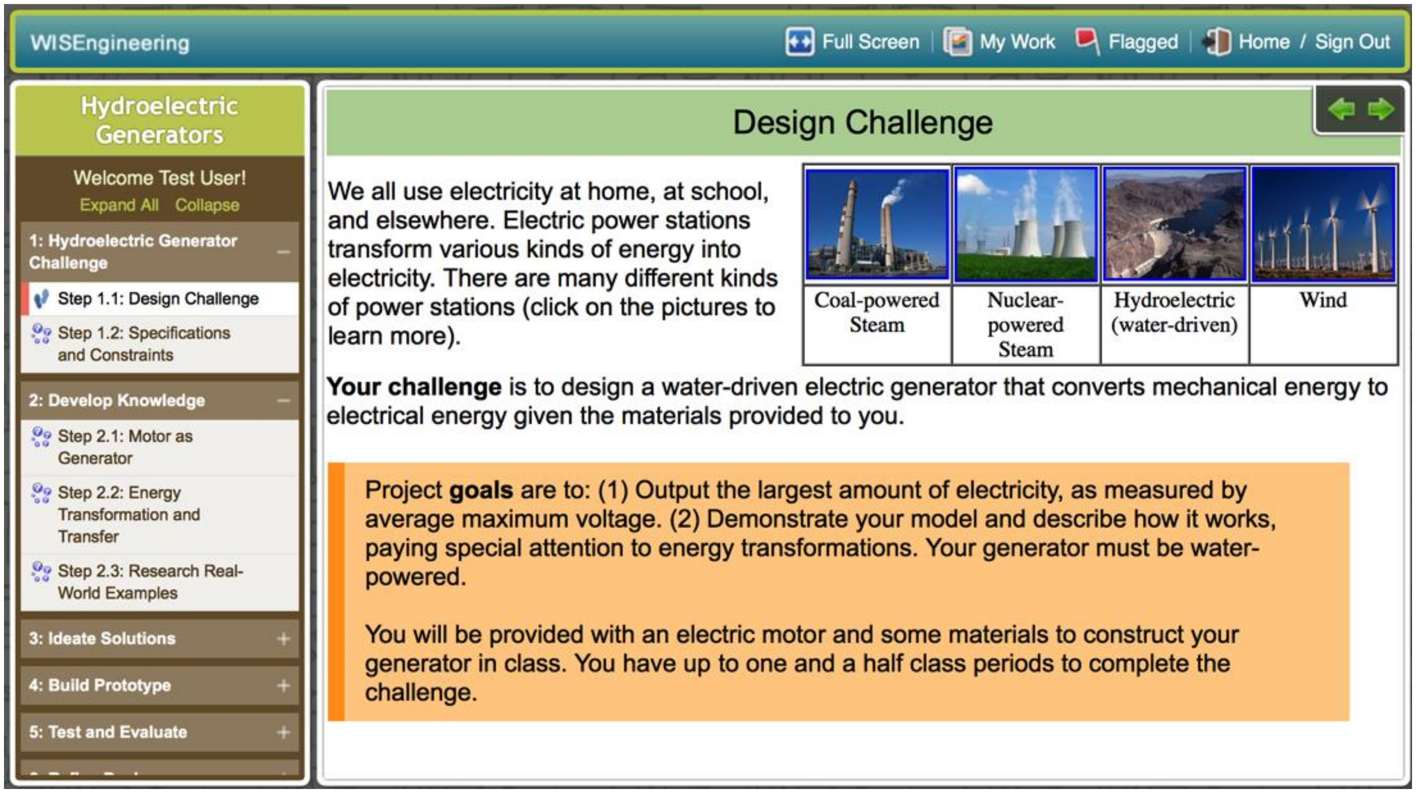
- Defining problems, designing solutions?
- NGSS means also teaching engineering!

WISEngineering

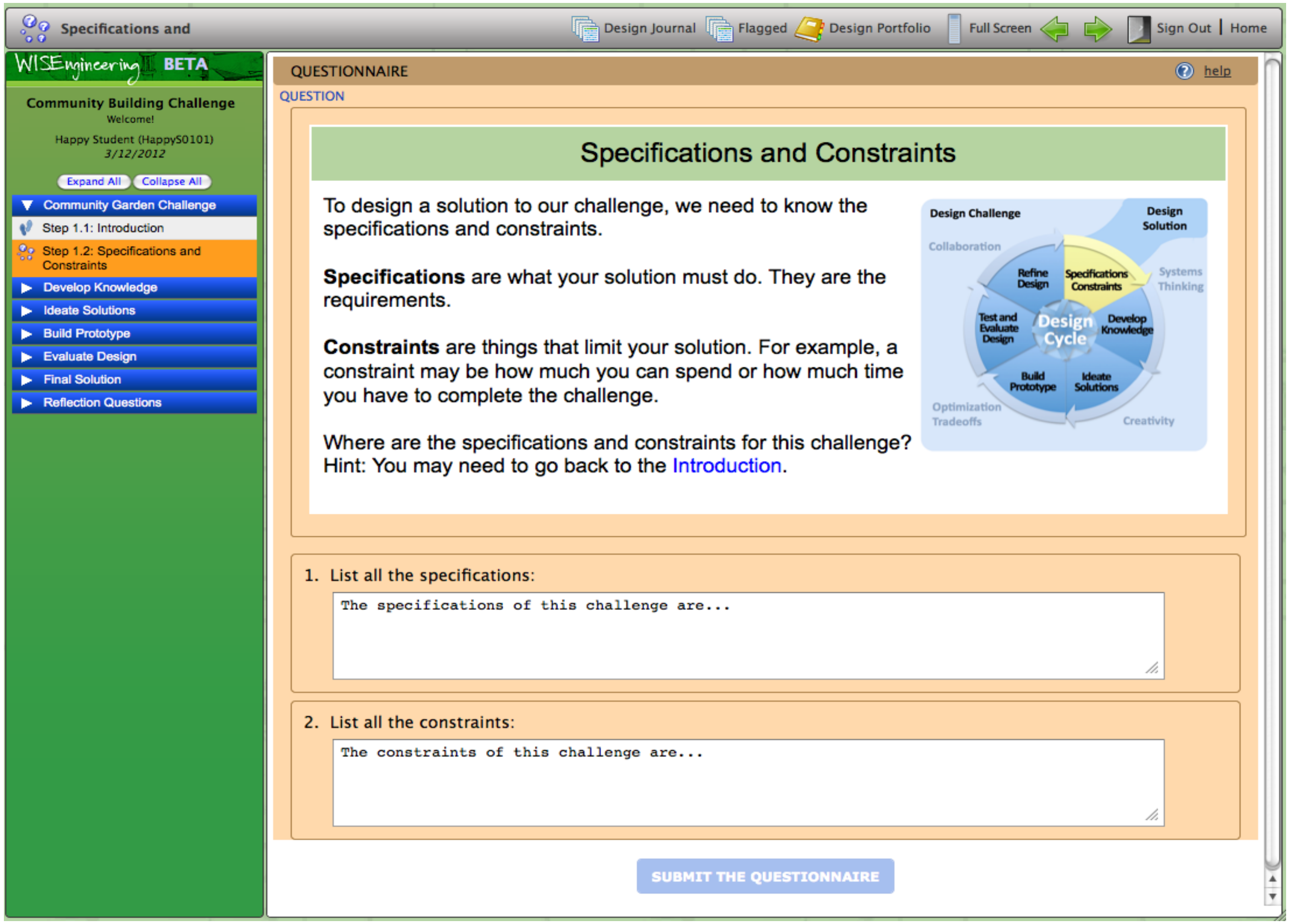
www.wisengineering.org



Supporting Engineering Design

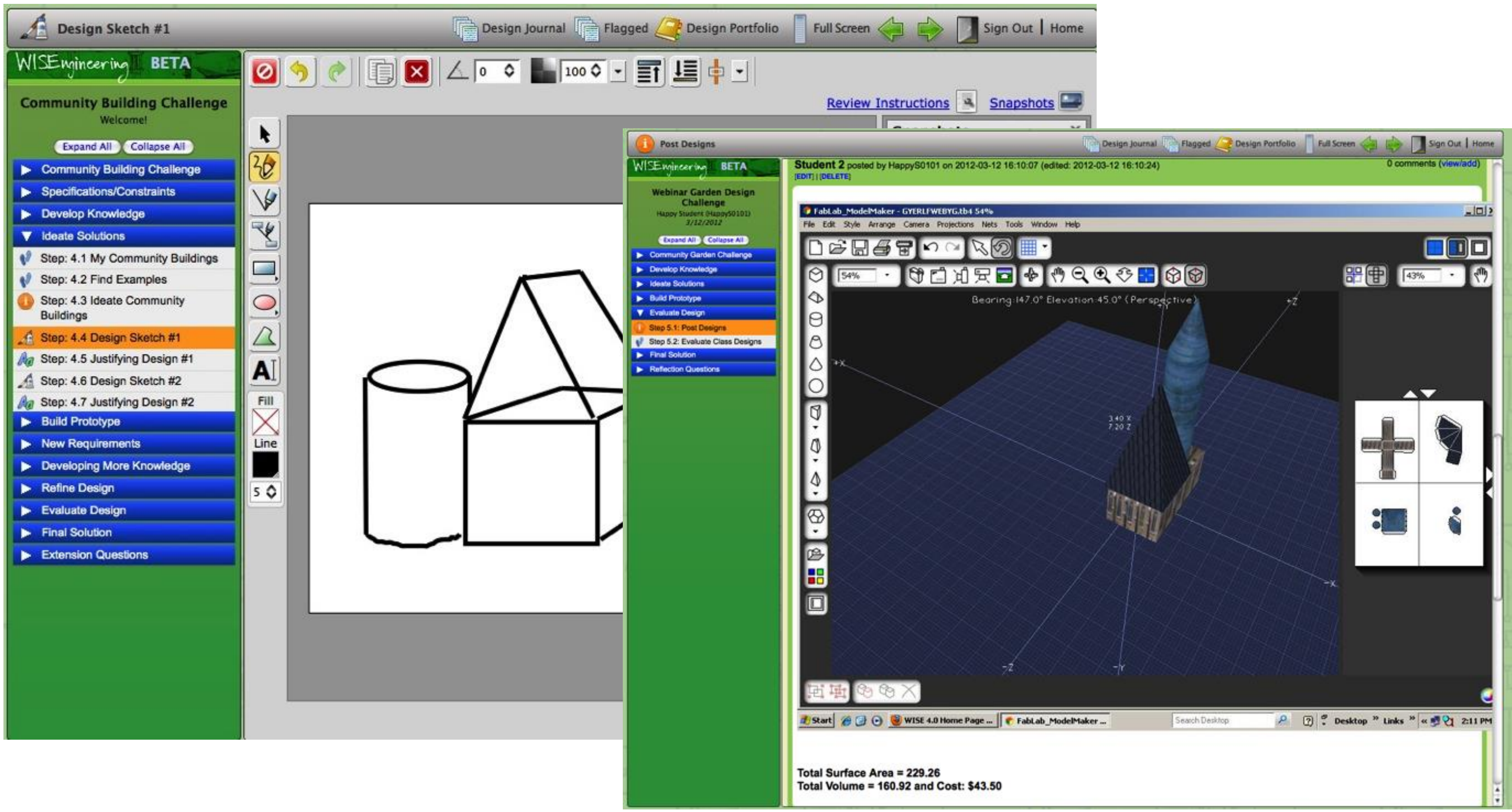


Defining problems

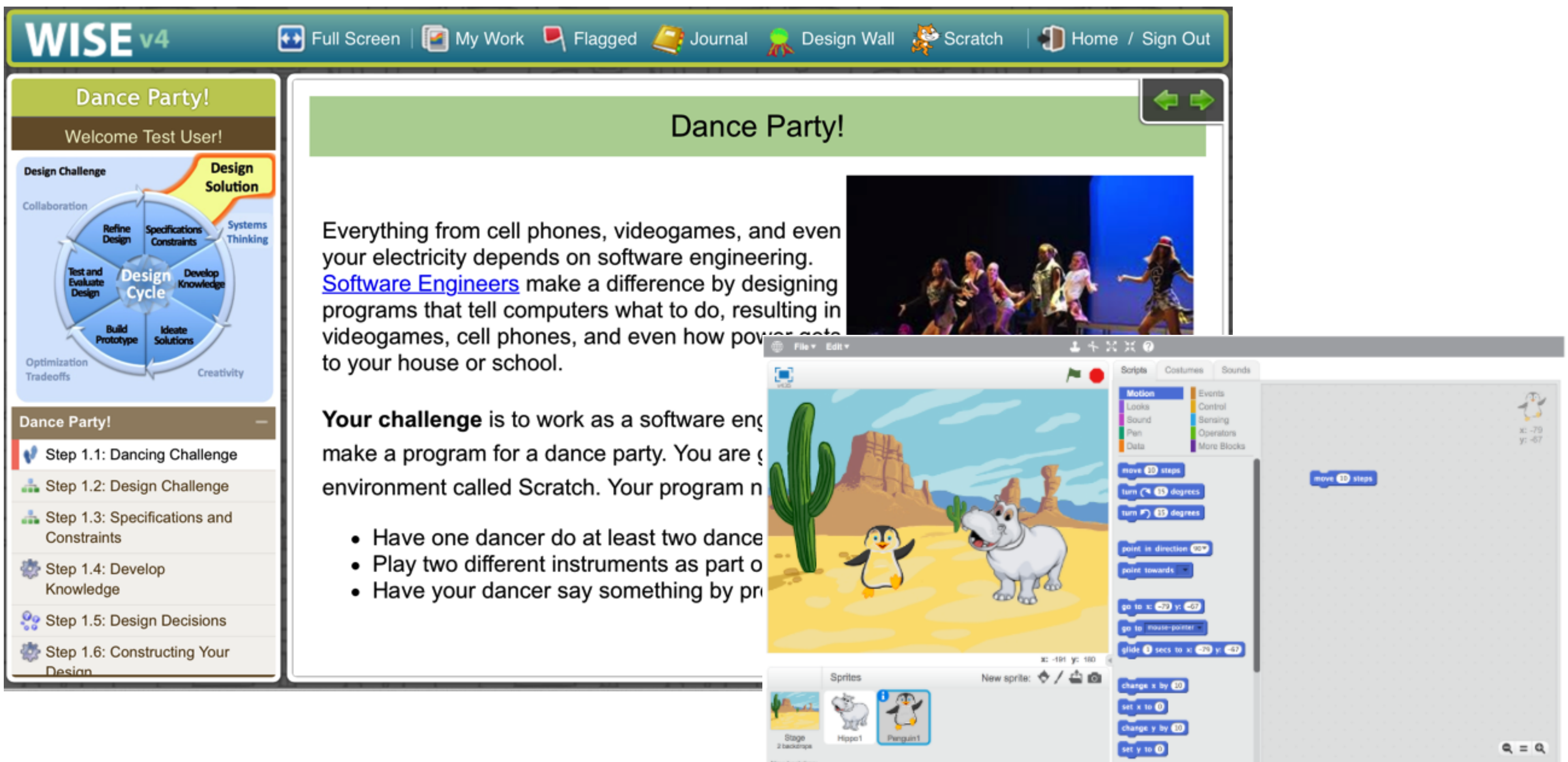


WISEngineering

Developing and using models

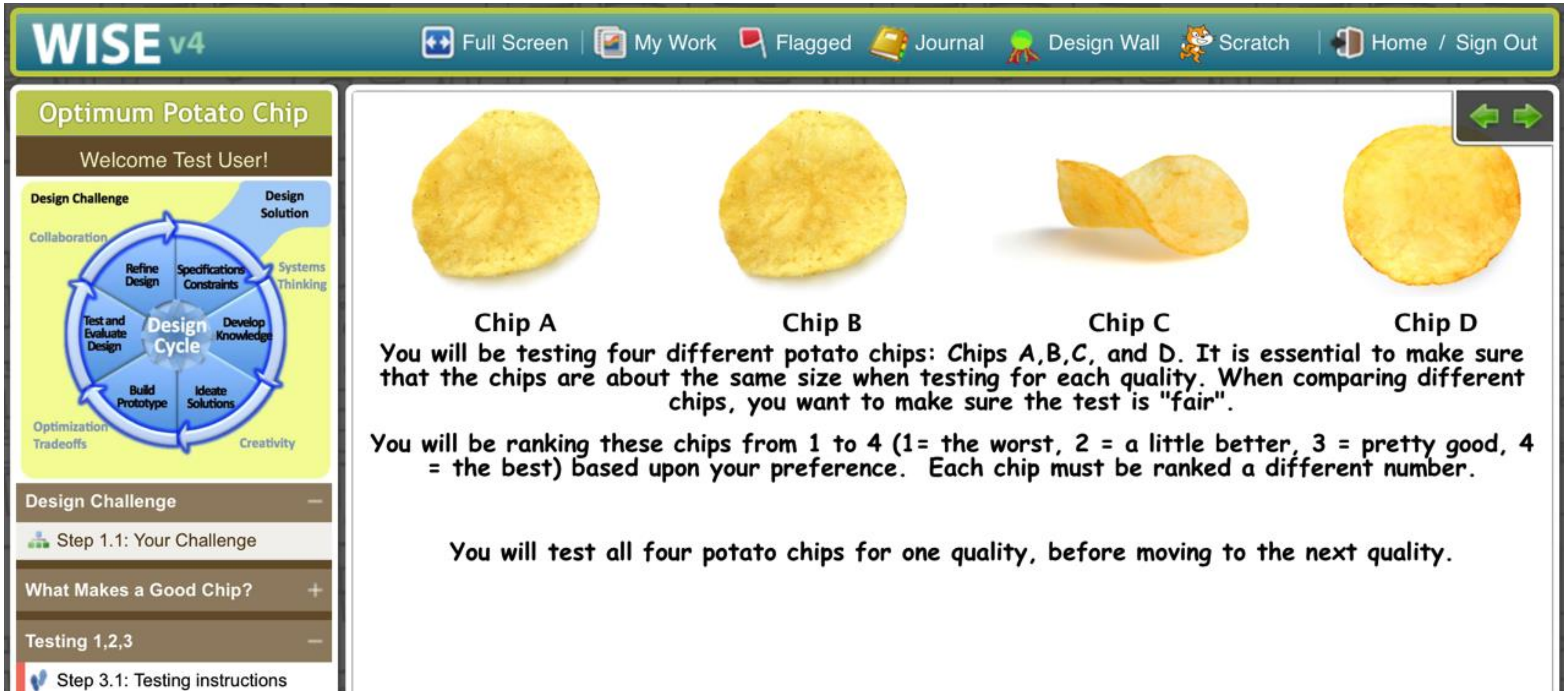


Using mathematics and computational thinking

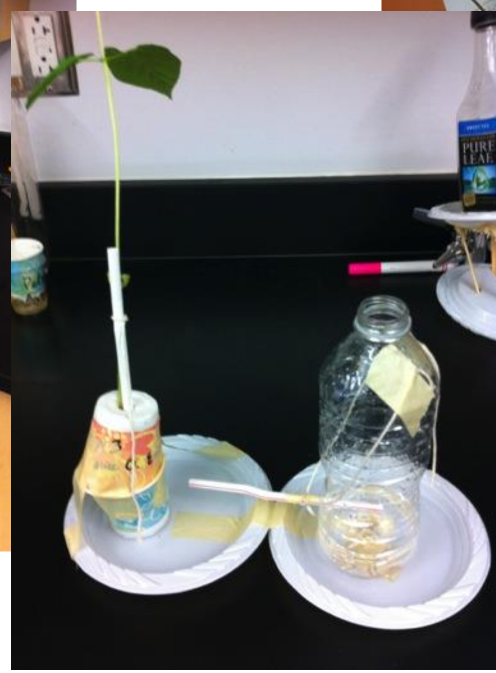


WISEngineering

Planning and carrying out investigations



Designing solutions



Engaging in argument from evidence

WISEngineering

- Currently have Common Core mathematics (TEM), NGSS Science units (STE), Informal activities with tablet computers
- Working on integrating math and science in schools

WISEngineering

- Engineering is applying science to real-world problems – science teachers already do this well
- Potentially very motivating for students
- Difficult to assess, implement

Questions and Discussion

Thank you!

WISE and WISEngineering teachers

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Thanks!

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- *Come visit us at CIRCLcenter.org*
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- *Download NETP '16*