Effective Use of Computer Simulations in the Inquiry-Based Science Classroom

Jenay Sharp Leach
## Four Level Model of Inquiry

How much information is given to the students?

<table>
<thead>
<tr>
<th>Level</th>
<th>Problem Supplied to Students?</th>
<th>Procedure Supplied to Students?</th>
<th>Results Supplied to Students?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Confirmation)</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
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</tr>
<tr>
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Modified From “Simplifying Inquiry Instruction,” by Bell, Smetana, and Binns, 2005
# Level of Inquiry: 1

What is provided to students?

<table>
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(Bell et al., 2005)
Explore Learning Gizmo™

• Photosynthesis Lab
• Not easily executed in the biology classroom
• Teacher should first run a brief tutorial to show students how to manipulate the Gizmo™ and read the data from the tables/graphs

Research Question and Hypothesis

• Question:

• Hypothesis:
Reflection

• What are ways to modify this lesson to achieve higher levels of inquiry?
The Effect of Mutation Rate on the Evolution of Blue Creatures

Variable Reproduction and Survival
Variable Reproduction and Survival
The Interface
The Independent Variable

Provide students with levels of treatment: 0, 0.5, and 1

**Mutation Rate (0 to 1)**

This number is the probability of a mutation occurring in any given cycle (reproduction event). If mutation occurs, there is an equal chance it will be an upward or downward mutation. (But note that if a mutation would produce a phenotype of 0 or 5, then it has no effect.)
The Dependent Variables

- **Mean Phenotype**: 3.65
- **Mutations**: 9 → 11 → 50
Research Question

What is the effect of mutation rate on the mean phenotype of the blue creatures over time?

Hypothesis

What do you think will happen to the mean phenotype (*reach length*) over time at different mutation rates?

As time increases, reach length will __________.
# Level of Inquiry

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Reflection:
How can we use simulations to address the science process skills?

Observing
Predicting
Measuring
Classifying
Communicating
Inferring
Experimenting

Hypothesizing
Interpreting data
Graphing
Identifying variables
Controlling variables
Formulating models
Level 3 Inquiry
Photoelectric Effect PhET™

https://phet.colorado.edu/en/simulation/photoelectric
## What is Level 3 Inquiry?

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(Bell et al., 2005)
Research Question

What factors affect electron energy?
Deducing Concepts and Relationships

Students do not yet know what the photoelectric effect is
Through experimentation, students learn how light intensity, wavelength, and voltage affect the current and electron energy
Students choose what/how variables are manipulated
Students replicate the original work that lead to the particle understanding of light
Class discussion to share results is crucial!
Level of Inquiry: 4
What is provided to students?

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(Bell et al., 2005)
Open Inquiry

• Students generate their own question, methods, and solution.

• A blank Experimental Design Diagram is helpful for students to plan their investigations
NASA Aeronautics FoilSim

http://www.grc.nasa.gov/WWW/k-12/airplane/foil3.html
Reflection

• How can open inquiry work in your classroom?

• What do we need to consider to make simulations work in our classrooms?
  – Instructional guidelines?
  – Best practices?
  – When to use in lesson sequence?
  – How to incorporate into existing curriculum?
Guidelines for Incorporating Simulations into Your Classroom
(Bell, Gess-Newsome, & Luft, 2008; de Jong & van Joolingen, 1998)

• Computer simulations are a supplement to other forms of instruction, not a replacement.
• Simulations are an ideal follow up for science lessons that involve variables that are difficult to manipulate in real-life settings as a result of resource, safety, or practical considerations.
• A simulation should allow the student to perform tasks that would be impossible without the simulation.
• Ensure that the link between the simulation and its real world applications are clear for the students.
Guidelines for Incorporating Simulations into Your Classroom
(Bell, Gess-Newsome, & Luft, 2008; de Jong & van Joolingen, 1998)

• A simulation activity that is teacher led should still engage the students with questioning, prediction generation, and conclusion drawing.

• Be sure to identify the limitations of a simulation.

• Familiarize your students with the technology before allowing them to navigate a simulation on their own.
Guidelines for Incorporating Simulations into Your Classroom
(Bell, Gess-Newsome, & Luft, 2008; de Jong & van Joolingen, 1998)

• Provide students a few minutes to explore the simulation prior to engaging in class goals (students will explore whether you give them time to do it or not so it is better to build it into the instruction).

• Closure is essential to a lesson that incorporates a simulation! Students should be given time to reflect and discuss the connection between the simulation and the real world.
Resources

PhET:
https://phet.colorado.edu/en/simulations/category/by-level/high-school

Explore Learning:
http://www.explorelearning.com/
Explore Learning™ simulations

- ExploreLearning™ produces simulations (Gizmos™) that model phenomena that would be difficult to replicate in a classroom. The Human Homeostasis Gizmo™ can be used in conjunction with a step-by-step packet:

- Most Gizmos™ ask a research question which students answer by completing a given procedure.
A Few of my Favorite NASA Resources

• Authentic science
• Not just for physics teachers! 😊
• LOTS more at NASA.gov ➔ For Educators [http://www.nasa.gov/audience/foreducators/#.UzhSUCiaLww](http://www.nasa.gov/audience/foreducators/#.UzhSUCiaLww)
Teaching from Space:
http://www.nasa.gov/audience/foreducators/teachingfromspace/home/index.html#.UzhJASiaLww

Explore Design Challenge:
http://www.nasa.gov/audience/foreducators/space-life/exploration-design/overview/index.html#.UzhKfCiaLww

NASA Apps for Phone or Tablet:
http://www.nasa.gov/connect/apps.html#.UzhLQyiaLww
Global Climate Change:
http://climate.nasa.gov/

Eyes on the Solar System:
http://eyes.nasa.gov/index.html

My NASA Data:
http://mynasadata.larc.nasa.gov/

Sample Lesson Plan:
http://mynasadata.larc.nasa.gov/lesson-plans/lesson-plans-hs-educators/?page_id=474?&passid=84
Reflection

• How can we use simulations to address the Nature of Science?