Using Simulations to Teach Scientific Practices

Jon Darkow  
Website: jondarkow.com  
Email: jdarkow@se-tigers.com  
Presentation Log-in: Peardeck.com/join  
Join Code: pvgac  
Presentation Resources: goo.gl/EK538D

GOALS:
- Generate questions
- Explore and test hypotheses iteratively and incrementally
- Experience the dynamics of a system to allow students to accept increased responsibility in constructing their own knowledge
- Experiment with variables and observe effects allows students a more active understanding about a system

WHY ARE SIMULATIONS IMPORTANT TO THE SCIENCE CLASSROOM?
- Reduces cognitive load by allowing students to explore and experience the results on the system from incremental changes.
- Allows students to breakdown phenomena into pieces
- Understand that scientific models are useful and limiting.

ADVANTAGES TO SIMULATIONS
Stave, Krytyna A. (2011)
- Simplify complex systems, and interact with parts of system structures that are not apparent.
- Speed up processing times helping learners experience and observe faster than they would observe in the real world.
- Keep track of learner decisions
- Reduce cognitive load by allowing students to focus on the underlying concepts rather than the complex mathematical calculations that are used to construct the simulations.
- Provide a platforms that are perceptually and spatially rich.
- Emphasize experience over explanation by allowing users to actively constructing their own learning by incrementally perturbing parameters of the simulation.
- Learners experiment with independent variables and observe how dependent variables change as a result.
WHAT ARE EFFECTIVE USES OF SIMULATIONS IN THE CLASSROOM?
Rehn, Moore, Podolefsky, and Finkelstein (2013)

1. Mediate discussion and assumptions, focus on illuminating cases, and coordinate multiple forms of representation
2. Gamify with discovery: perturb, run, reflect
3. Experiment and practice science: predict, observe, and explain
4. Recreate or represent features

1. **Multiple Forms of Representation**

   ![Conceptual Diagram](image)

   **Concrete**

   ![Concrete Diagram](image)

   **Experimental**

   ![Experimental Diagram](image)

   **Computational**

   ![Computational Diagram](image)

2. **Gamify with Discovery: Perturb, Run, Reflect**
What is the carrying capacity of the white-footed mouse population?

3. **Experiment and Practice Science: Predict, Observe Explain**
CER Model (From [Data Nuggets](#))

   ➔ **Claim:** Restate the scientific question with the answer that is suggested by examining the data.
   ➔ **Evidence:** What evidence (data) supports your claim?
   ➔ **Reasoning:** Reasoning links evidence to the claim using scientific principles.

**Claim:** *Enzymes have an optimal temperature for their rate of reaction*
### Evidence:

<table>
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<th>Temperature</th>
<th>Initial Lactose</th>
<th>pH</th>
<th>At 10°C (dL/3 min)</th>
<th>At 30°C (dL/3 min)</th>
<th>At 80°C (dL/3 min)</th>
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<td>Mean</td>
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</table>

### Reasoning:

4. **Recreate or represent features**

*Draw how the lactase would change at 30°C, versus 80°C.*

![Diagram of lactase enzyme at 30°C and 80°C]

### My Favorite Simulation and Exercise:

Simulation: C-Learn, climateinteractive.org/tools/c-learn/

World Climate Exercise: climateinteractive.org/programs/world-climate/

### Works Cited


