Developing a 3-D NGSS High School Science Unit

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October 2015 • California STEM Symposium • Anaheim, CA
This session showcases how to develop and teach a three dimensional sequence of lessons to teach about the ocean's influence in global climate change. This lesson sequence was showcased in the California NGSS Roll Out II symposium, learn how it was developed so you can transfer the process to your own units.
The California NGSS Roll Out Symposia are brought to you by the California NGSS Collaborative: California Superintendents Educational Services Association, California Department of Education, California Science Teachers Association, California Science Project, and the K-12 Alliance/WestEd.
Where are we in terms of NGSS implementation?

**NGSS Recap**

- **Grace, Orlinsky, & Henriques**
- **Developing a 3-D NGSS High School Science Unit**
- **October 2015**
- **California STEM Symposium**
- **Anaheim, CA**
Using a **phenomenon**
to anchor instruction

- As you view the **video**, think about what questions you have
- As a team, use three post-its to record your teams top three questions
Let’s Investigate a question

Your challenge is to stack three different colors of water into a single straw!

Test it out:
Have you ever “caught” water in the end of a straw before? Put your finger on the end of the straw opening, dip the end of the straw into one of the containers of water, and quickly lift up your finger and then put your finger back on the top of the straw opening. Keeping your finger in place on the top of the straw, you will notice that you can remove the straw from the water and the straw will hold water from the container.

Your challenge:
In front of you are waters with different colors, each color representing water with a different density. Your challenge is to determine which container of water has the lowest density, second lowest, third lowest, and highest density. We will know you have met your challenge when you can successfully stack all three colors in a single straw!

Before you start:
Record your predictions (with rationale) in your notebook explaining what you think will happen and why.

When you are done:
Record your observations in your notebook (sketches with labels are also good) and explain how you think what you have just learned in this station might impact your shoebox ocean model.

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Next Investigation

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More Investigations

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Ocean Shoebox model

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Isolating model to thermal energy
Using model to develop a mathematical relationship

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Theme (energy) - centering the unit around the big idea: *The Earth’s Climate Constantly Changes* was a natural way to develop this theme.
The Planning Process

* Theme (energy)
* Build a unit conceptual flow
The Earth’s Climate Constantly Changes

A cycling of energy connects climate to carbon and water cycles

A change in one cycle (energy, water, or carbon) will impact the other two as the system moves to a new equilibrium

Climate change is a change in the balance of the cycles

Paleoclimatic evidence indicates the Earth’s climate has constantly changed

Some changes have more long-standing impacts than others

Changes in the Earth’s orbit and axial tilt influence climate for thousands of years

Solar output and disruption of oceanic currents influence climate for hundreds to thousands of years

Human activity and large volcanic eruptions influence climate for tens to hundreds of years

Amplifiers in the climate system, such as ice and greenhouse gases, disrupt balance and provide feedback for climate change

Evidence from the past as well as current climate models predict an increase in global temperatures

Conservation of energy requires that the incoming energy from the sun is balanced by “heat” radiated to space

Some of the energy radiating to space is depended upon the amount of energy absorbed, reflected, and emitted by the Earth and the amount trapped by the greenhouse effect of the atmosphere (gasses and clouds)

There are many components involved in water cycling, the oceans hold most of the Earth’s water

To fully understand the role of the ocean in climate, scientists create models to test hypotheses of ocean circulation and oceanic changes

The Earth possesses reservoirs of carbon including the ocean which acts as a long-term reservoir

Molecules with carbon move between surface ocean, deep ocean, soil, animals, plants, fossil fuels, and atmosphere

Carbon dioxide dissolved in cooler water but is released from warmer water

Ocean circulation drives global weather patterns

Biological activity, freshwater input, and changes in sea surface temperatures all influence oceanic expansion/contraction, salinity, density, and carbon levels

Carbon molecules (as well as clouds and water) provide a greenhouse effect

The main source of energy for the Earth comes from the sun.

CA NGSS Rollout#2: 5E Learning Sequence Example
Grades 9-12
The Planning Process

- Theme (energy)
- Build a unit conceptual flow
- Performance Expectation (PE) and Disciplinary Core Idea (DCI) matching
Planning Process: PE and DCI Matching

Flow with DCI's and PE's

The Earth's Climate Constantly Changes

- A cycling of energy connects climate to carbon and water cycles
- A change in one cycle (energy, water, or carbon) will impact the other two as the system moves to a new equilibrium

Climate change is a change in the balance of the cycles

- Paleoclimatic evidence indicates the Earth's climate has constantly changed
- Some changes have more long-standing impacts that others

There are many components involved in water cycling, the oceans hold most of the Earth's water

- To fully understand the role of the ocean in climate, scientists create models, to test hypotheses, of ocean circulation and oceanic chemistry
- The Earth has reservoirs of carbon which acts as a term reservoir

Carbon dioxide dissolved in cooler water but is released from warmer water

- Biological activity, freshwater inputs, and changes in sea surface temperatures all influence oceanic expansion/contraction, salinity, density, and carbon levels
- Ocean currents drive global patterns

Carbon molecules (as well as clouds and water vapor) provide a greenhouse effect

Some of the Earth's energy is radiated back to space, dependent on the amount absorbed and emitted at the surface

Conservation of energy requires that the incoming energy from the sun is balanced by heat radiated to space

- PS3.B Bullet 1
- HS-PS3-1

- PS3.B Bullet 2
- HS-PS3-1

- PS4.B Bullet 2
- HS-PS4-4

- ESS2.B Bullet 1
- HS-ESS2-4

- ESS2.D Bullet 1
- HS-ESS2-6

- ESS2.C Bullet 1
- HS-ESS2-5

- ESS1.B Bullet 1
- HS-ESS2-4

- ESS2.A Bullet 1
- HS-ESS2-2

- ESS3.D Bullet 1
- HS-ESS3-5

- ETS1.A Bullet 2
- HS.ETS1-1

- ESS2.D Bullet 2
- HS-ESS2-3

- ESS2.A Bullet 2
- HS-ESS2-4

- ESS3.D Bullet 2
- HS-ESS3-4

- ESS3.A Bullet 3
- HS-ESS3-3

- ETS1.A Bullet 3
- HS.ETS1-1

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The Planning Process

- Theme (energy)
- Build a unit conceptual flow
- Performance Expectation (PE) and Disciplinary Core Idea (DCI) matching
- Science and Engineering Practice (SEP) matching (*Mathematical and Computational Thinking*)
- Crosscutting Concept (CCC) matching (*Systems and System Models*)
The Planning Process

* Theme (energy)
* Build a unit conceptual flow
* Performance Expectation (PE) and Disciplinary Core Idea (DCI) matching
* Science and Engineering Practice (SEP) matching
* Crosscutting Concept (CCC) matching
* Choose a “chunk” for a lesson sequence
The Planning Process

* Choose a phenomenon

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The Planning Process

* Theme (energy)
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* Choose a “chunk” for a lesson sequence
  * Choose a phenomenon
  * Build a 5E learning sequence
## 5E Learning Sequence

<table>
<thead>
<tr>
<th>Stage</th>
<th>T</th>
<th>S</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage 1-2</td>
<td></td>
<td></td>
<td>The ocean has currents</td>
</tr>
<tr>
<td>Explore 1</td>
<td></td>
<td></td>
<td>Currents result from differential density of ocean water due to temperature differences and salinity differences</td>
</tr>
<tr>
<td>Explore 2</td>
<td></td>
<td></td>
<td>Major oceanic currents traverse the globe and circulate thermal energy</td>
</tr>
<tr>
<td>Explore 3</td>
<td></td>
<td></td>
<td>Scientists can model ocean circulation</td>
</tr>
<tr>
<td>Explain 1-2</td>
<td></td>
<td></td>
<td>To fully understand the role of the ocean in climate, scientists create models to test hypotheses of ocean circulation and oceanic changes</td>
</tr>
<tr>
<td>Elaborate 1-2</td>
<td></td>
<td></td>
<td>Ocean circulation drives global weather patterns (Elaborate 2 and 3 not modeled in this session)</td>
</tr>
<tr>
<td>Evaluate 1</td>
<td></td>
<td></td>
<td>All concepts (Evaluate 2 not modeled in this session)</td>
</tr>
<tr>
<td>Elaborate 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaborate 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluate 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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* Performance Expectation (PE) and Disciplinary Core Idea (DCI) matching
* Science and Engineering Practice (SEP) matching
* Crosscutting Concept (CCC) matching
* Choose a “chunk” for a lesson sequence
  * Choose a phenomenon
  * Build a 5E learning sequence
* Collaborate with colleagues – lots of collaboration!

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Collaboration with Colleagues

Colleagues who gave input during the planning process:

* Brian Colburt and Chris Todosiev, math teachers at PVIS
* Mike Gunson, Joshua Willis, and Susan Callery of NASA’s Jet Propulsion Lab/California Institute of Technology
* California NGSS Collaborative
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- Choose a “chunk” for a lesson sequence
  - Choose a phenomenon
  - Build a 5E learning sequence
  - Collaborate with colleagues – lots of collaboration!
- Cross-check NGSS Evidence Statements

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Walk, don’t run. Don’t stand still!

* Take your time and get help!
Resources

* NGSS Evidence Statements
  * http://www.nextgenscience.org/ngss-high-school-evidence-statements
* California NGSS Roll Out Symposium resources (my digital chalkboard)
  https://docs.google.com/document/d/1CHjrfqhnlyXihsmnbMq_feV3sfRqUdly_z-Bi2ZGEA/pub
* CSTA’s NGSS Resources
  * http://www.cascience.org/csta/ngss.asp
* Achieve’s NGSS Resource Page
  * http://nextgenscience.org/resources
* NSTA’s NGSS Resource Page
  * http://ngss.nsta.org/
* CSLNet LCAP toolkit
Thank you

*Handouts and PowerPoint for this session

http://bit.ly/1MMUJuuw

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