The Ocean Sciences Curriculum Sequences

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Climate Literacy & Energy Awareness Network
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Overview of Presentation

- Overview of the GEMS-MARE Ocean Sciences Curriculum Sequence
- Quick look at one session
- Development Process
- How they address common core and NGSS
- How and where these are being used in schools/districts &…
- Finding the Ocean Sciences sequence and other resources
- Q&A and Discussion
Background on the Lawrence Hall of Science Curriculum Development Efforts

Lawrence Hall of Science (LHS) is:
- a leading developer of supplemental science instructional materials,
- has the longest running elementary and middle school marine science program in the U.S., called MARE

At least 25% of all K-12 students in the U.S. use science instructional materials developed by LHS.
- ≈ 800,000 teachers and 12 million students have experienced the 70+ GEMS instructional units

The U.S. DOE and NASA have both identified GEMS as a high-quality educational partner
2 awards (2007, 2009) – each one covered curriculum for each grade band

- Common characteristics of both projects
  - Subject matter experts
  - Content Guided by the Ocean Literacy principles & concepts
  - Integration of NOAA-related data and other resources
LHS organized a Partners Meeting of topic specialists & experts in Aug 2010 to plan the OSS 6–8 curriculum

Meeting included educators, curriculum developers, scientists, and evaluators, working together for several days

Scientist and educator participation and online review was broad; entire group discussed key topics for curriculum to cover, sequence, pedagogical approach, interconnections, and depth of coverage

Follow up one-on-one conversations with curriculum developers, and review of pilot materials
Science Advisors & Reviewers

From Rutgers University’s Institute of Marine and Coastal Sciences

* Dr. Bob Chant
* Dr. Jim Miller
* Dr. John Wilkin
* Dr. Elizabeth Sikes
* Dr. Oscar Schofield
* Dr. Josh Kohut
* Dr. Scott Glenn
* Dr. Carrie Ferraro
* Kristin Hunter-Thomson
* Janice McDonnell

From Other Institutions:

* Dr. Adina Paytan (UC, Santa Cruz)
* Dr. Robert Rhew and Dr. John Chiang (University of California, Berkeley)
* Dr. Michael Mann (Penn State)
* Eric Simms & Daniel Richter (Scripps)
* Dr. Paulo Maurin (NOAA)
* Dr. John Manderson (NMFS)
* Dr. David Mountain (NOAA/NMFS, ret.)
* Dr. Ann Ball (NOAA Coastal Services)
* Dr. Drew Talley (U. San Diego & NERR)
* Sarah Ferner (San Francisco NERR)
* Terri Kirby-Hathaway (NC Sea Grant)
* Dr. Diana Payne (University of CT, Sea Grant)
* Dr. Fritz Stahr (University of Washington)
Ocean Sciences Sequence Overview
Grades 3–5

Unit 1: What kind of place is the ocean?
Covers Earth and physical science themes about the ocean as a physical space with unique characteristics

Unit 2: What is life like in the ocean?
Covers life science themes, with a specific focus on food webs, habitats, and adaptations

Unit 3: How are humans and the ocean interconnected?
Covers life science and environmental science themes, with a specific focus on how humans use the ocean, pollution, fisheries, and how people can help care for life in the ocean
Unit 1: How do the ocean and atmosphere interact?

Students learn about:

- Density & how it relates to movement of water, air and heat on Earth
- Ocean and air currents
  - What sets them in motion?
- Climate and weather patterns
  - How does the ocean affect climate on Earth?
- Water cycle
- Flow and exchange of heat energy around Earth
- Thermal expansion & water as a heat reservoir
Unit 2: How does carbon flow through the ocean, land, and atmosphere?

Students learn:

- Carbon flows in Earth’s system through respiration, photosynthesis, absorption, decay & combustion
- An imbalance in carbon cycle from burning fossil fuels
- An increase in CO₂ in atmosphere increases CO₂ in the ocean
- Increasing CO₂ in the ocean causes ocean acidification & affects organisms
Unit 3: What are the causes & effects of climate change?

Students investigate:
- Greenhouse effect
- Melting glaciers and sea ice
- Sea level rise
- Human contributions to rising atmospheric Co$_2$
- Effects on organisms & ocean-atmosphere connections

Students gain an understanding of the underlying causes of climate change & the effects on Earth & some possible solutions
Before this session, students learn that:

- Carbon flows through various reservoirs on Earth through the processes of photosynthesis, respiration, decomposition, and absorption.
- Carbon can move into fossil fuel and limestone reservoirs after organisms die.
Carbon Cycle Flow Cards

**Human Industry: Making Cement**
(.3 gigatons per year)

**Flow**

**Human Industry: Combustion of Fossil Fuels**

In the last ~100 years, humans have taken more and more crude oil and other fossil fuels from underground and used them to power cars, machines, and more. The fossil fuels are burned, and carbon is released into the atmosphere as CO₂.

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Carbon Cycle Cards—Ocean Sciences Sequence 2.7–2.8
Guiding Question:

How does human industry affect flows of carbon in the carbon cycle?
Sample flows from the interactive Carbon Cycle diagram:

**Flow: Animal Respiration (30 gigatons per year)**
When animals break down the food they eat, they breathe out CO₂ into the atmosphere.

**Flow: Human Industry: Combustion of Fossil Fuels (7.6 gigatons per year)**
From fossil fuels into atmosphere
In the last ~100 years, humans have taken more and more crude oil and other fossil fuels from underground and used them to power cars, machines, and more. The fossil fuels are burned, and carbon is released into the atmosphere as CO₂.

Click outside the card to return to the diagram.
Paper Clip Carbon Cycle Model #1

1. Plants and Photosynthetic Ocean Organisms (green paper clips)
2. Animals (red paper clips)
3. Ocean (blue paper clips)
4. Fossil Fuels and Limestone (black paper clips)
5. Atmosphere (white paper clips)

1. Do not leave the reservoir
2. Do not leave the reservoir
3. Do not leave the reservoir
4. Do not leave the reservoir

1. Release
2. Animals eat animals
3. Animals eat plants
4. Animals breathe out
5. Volcanic eruptions
6. Decay and burial
7. Decay and burial
8. Natural leaks
Fossil Carbon Output from Human Industry

- **TOTAL**
- **Crude Oil**
- **Coal**
- **Natural Gas**
- **Cement Production**

**Time (years)**
- 1800
- 1850
- 1900
- 1950
- 2004

**Million metric tons of carbon/year**
- 1000
- 2000
- 3000
- 4000
- 5000
- 6000
- 7000
- 8000
• Carbon moves between reservoirs, but the total amount of carbon on Earth doesn't change.

• Human industry moves carbon out of fossil fuel and limestone reservoirs and into the atmosphere.
OSS Alignment to Standards

Ocean Literacy Framework & Climate Literacy
◆ Aligned & guided by Ocean and Climate Literacy frameworks

NGSS & Framework for K-12 Science Education
◆ Aligns well to disciplinary core ideas and science and engineering practices

Common Core States Standards for English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects
◆ Several Science & Engineering Practices from NGSS and Framework are synergistic with Common Core
Common Core ELA

E1. Demonstrate independence in reading complex texts and in writing and speaking about them
E6. Use technology and digital media strategically and capably
E7. Come to understand other perspectives and cultures through reading, listening, and collaborations

E2. Build a strong base of knowledge through content-rich texts
E3. Obtain, synthesize, and report findings clearly and effectively in response to task and purpose
E4. Construct viable arguments and critique reasoning of others
E5. Read, write, and speak grounded in evidence

Next Gen SCIENCE

S1. Ask questions and define problems
S2. Develop and use models
S3. Plan and carry out investigations
S4. Analyze and interpret data
S5. Use mathematics and computational thinking
S6. Construct explanations and design solutions
S7. Engage in argument from evidence
S8. Obtain, evaluate, and communicate information
Current Use of the OSS Materials

- Used by teachers in schools, as intended (Boston, Bellingham, Santa Barbara, Taholah School on the Quinault Reservation, 140 field test teachers, etc.)
- 2 NSF-funded Climate Change Education Partnership projects
- Adult level content learning for elementary and middle school teachers
- Professional development focused on Argumentation
- College courses (Communicating Climate Science)
- Focus of 2 NSF research projects (argumentation & science identity)
- Summer Camp for Middle School students
- Classroom support materials for Ocean Acidification cruise, teacher at sea program
- Recommended for funding to use OSS 6-8 in preservice programs across the country
Where Can You Find the Ocean Sciences Sequence?

NGSS Alignments, Simulations & Sample lessons:

http://mare.lawrencehalloffscience.org/curriculum/ocean-science-sequence

OSS is available from Carolina Curriculum at:

www.carolinacurriculum.com/gems