6th Grade **Year-long activity**

TEACHING "BIG PICTURE" SCIENCE: AN ISLAND FORMATION SIMULATION

Oregon Science Content Standards:

6.1 Structure and Function: Living and non-living systems are organized groups of related parts that function together and have characteristics and properties.

6.1E.1 Describe and compare the properties and composition of the layers of Earth.

6.2 Interaction and Change: The related parts within a system interact and change.

6.2L.2 Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources.

Ocean Literacy Principles:

1. The Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of the Earth.
4. The ocean makes Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.

Goal: to promote an understanding of the interconnectedness of big scientific concepts such as plate tectonics, island formation, geological time-scale, natural selection, evolution, and ecosystems

Concepts:

- Volcanic island formation
- plate tectonics
- ecosystem
- natural selection
- evolution
- dispersal
- recruitment

- colonization

Materials:

- Brown and blue butcher paper
- Markers or paint for elaboration of the island
- 600 3x5 note-cards
- Colored pencils for all students
- Scotch tape
- Photos of tropical islands and newly formed volcanic islands (Surtsey and Krakatoa are good examples)
- Lessons on plate tectonics, volcanic island formation, erosion and soil formation, ecosystems, natural selection, biodiversity, etc.

Abstract:

This is a long-term classroom simulation of the formation and subsequent colonization of a volcanic island. The simulation spans many thousands of years and can incorporate a range of science concepts. The primary goal of the simulation is to promote an understanding of the interconnectedness of big scientific concepts such as plate tectonics, island formation, geological time-scale, natural selection, evolution, and ecosystems. This simulation is meant to provide a real-world framework for lessons already taught. The simulation is “game-like” and is extremely engaging for students.

Introduction:

This activity is a simulation of island evolution through time, which ties together many different geological and biological concepts into a “big picture.” In teaching certain scientific concepts we often fail to give students proper context, giving rise to a disjointed view of scientific principles. For example, in teaching photosynthesis, students will understand the requirements of the chemical reaction, but we may fail to teach how photosynthesis is required for the functioning of the entire ecosystem. We live in a world where everything is interconnected. On a global scale, this can be hard for anyone to grasp. The “Our Island” simulation puts interrelated concepts such as, natural selection, evolution, food webs, weather and ocean currents into the more manageable context of a small, recently formed volcanic island. It reinforces the interconnectedness of these concepts on a weekly basis in a fun and engaging activity that incorporates art and writing.

In this activity, the class creates an island landscape and ecosystem in the classroom over the course of the year. Students start out with a newly formed volcanic island, which they then populate with organism cards they have created. These cards have drawings of organisms on the front, and descriptions of the needs of the organism on the back. With a little creativity, this ongoing simulation can be tied in with lessons about the following concepts:

Island Formation	Evolution
Endemism	Speciation
Erosion/Soil Formation	Genetics
Ecology	Coral Reef Formation
Colonization (via larval or seed dispersion)	Biodiversity
Natural Selection	Photosynthesis

This activity is appropriate for grades 5-9. We recommend that this activity be introduced at the beginning of the year so many life science lessons can be related to it throughout the year. Each relevant lesson should include a discussion of how Our Island is affected by the concepts covered in the lesson. After initially introducing the simulation, it takes about 30 minutes a week to keep it running throughout the year.

Natural selection, and ultimately, evolution, are fundamental concepts covered in Our Island. We found students readily accepted natural selection, but the term ‘evolution’ gave rise to some controversy in the classroom. We responded to the controversy by teaching well-known examples of ‘microevolution’ or the slight alteration of a population to adapt to changing environments over time spans observable within a human lifespan. Microevolution should be emphasized as a commonly observed occurrence, which can be used to infer what has happened to species in the past, over huge expanses of time. See the “Understanding Evolution” website for lessons on evolution, cited below.

Lesson Plan:

Before class, create the Our Island background poster. Using butcher paper, cut out a light blue background of at least 3’ x 4’ (larger is better). Cut out and glue on a conical island out of brown butcher paper, this should fill up a large portion of the poster and go all the way to the bottom of the page. Use paint or a blue marker to draw water covering the bottom 1/3 of the poster. You should still be able to see the submerged part of the island. At the top of the poster, create a timeline with 20,000 year increments starting at 1,000,000 BC and ending with the present. Include a movable marker (an arrow with masking tape works well) to show where our island is on the timeline. Color-code the Pleistocene and holocene epochs.

Session 1 (Coincides with lessons about plate tectonics and hotspot volcanic island formation; 45 minutes):

Preliminary discussion: have the students brainstorm what comes to mind when they think of a newly formed, tropical volcanic island. After brainstorming, show several photographs of newly formed volcanic islands such as Krakatoa and Surtsey, ("Surtsey" 2011). Brainstorm about how a new island turns into a place like Hawaii. For terrestrial colonization, erosion has to take place for soil formation and plants and animals have to somehow make their way onto the island. How do plants and animals get to the island? Does this happen overnight?

Explain to the class that they are going to make their own volcanic island, complete with organisms, over the course of the next few weeks or months. Put up the Our Island poster and introduce it as a brand new volcanic island in the tropical pacific (2,000 miles from shore) in the year 1,000,000 BC. To promote interest and ownership of the island, have the class propose names and vote on what they want to call their island.

Session 2 (Coincides with erosion and soil formation lessons; 15 minutes)

Discuss erosion and soil formation, move the marker 20,000 years up the timeline and draw some soil on your island. Our students drew clouds on the leeward side of the island and had the rain shadow effect create a wetter environment (streams and lakes) on one side of the island and a drier environment on the other. Take artistic liberty with your island!

Session 3 (Colonization; 1hr)

This is a good time to teach about island colonization, using Surtsey as an example. The Surtsey Research Society has an excellent website documenting how Surtsey, a newly formed volcanic island, is currently being colonized by various pioneering terrestrial and marine species.

Now that we have a little soil and some water on our island, it is time to populate it with organisms. Place students in groups of 5 and have them come up with lists of realistic ways that plants, animals, and fungi can get to the island. Create a master list on butcher paper at the front of the class. The list should look something like this:

a) Rafting: fungus, moss, plants, and very small animals such as insects and worms may ride over on floating logs. (Note: humans do not have the technology to build boats at this point in time).
b) Wind: Fungal spores and some kinds of seeds can blow on the wind from other islands nearby.
c) Flying: Small birds and bats have the ability to fly from nearby islands. Seabirds and larger land birds have the ability to fly extremely long distances and can fly from the mainland, 2,000 miles away!
d) Hitchhiking: Seeds, fungus spores, and some insects can hitchhike on these flying birds.
e) Swimming and Drifting: Fish, squid, marine mammals, jellyfish, algal spores and the larval forms of sessile invertebrates (anemones, coral, crabs, sea-worms) can swim to the island or drift on the currents.

Now explain to the students that they will create cards that have plants and animals on them that will be randomly drawn from a hat and added to the island each week. Some will survive, some will perish, and some will evolve into something a little more adapted to life on a volcanic island. On the front of the card students should make a colored pencil drawing of the organism and write the name of the organism across the top. Names should be specific, but don't necessarily need to be real species. On the back of the card students will write three things: how the organism got to the island, what the organism needs for energy (relate back to photosynthesis and food web lessons already taught); and what kind of habitat the organisms needs. Students must be specific! Draw an example of the front and back of a card on the board.

Assign students to make 3 cards each. Plants, bacteria and fungi are more abundant on the planet, and are more likely to get to the island, so require at least 2 of each student's cards to be primary producers or decomposers. The third card can be their choice, and additional cards can be accepted for extra credit. Note: This is a good time to teach lessons about ecosystems. In a functioning ecosystem, you have more primary producers and decomposers than primary consumers, and even fewer secondary consumers and top predators. It should be stressed that this is true in marine and land ecosystems.

Session 4 (Coincides with natural selection lessons; 15 minutes)

Place the students' cards in a hat and call individual students to the poster to draw a card, read it out loud, and place it on the board. If the method by which that organism gets to the island seems dubious, do not place it on the board. The cards should be taped so they can be flipped up and read. Marine animals should go in the water; animals that need moisture should go to the wet side of the island, etc. Put 10-15 organisms on the island. Encourage the students to predict which animals will survive, and which will perish. Leave the rest of the cards in the hat to be drawn from later. This pool of organisms gets larger as the year progresses. You'll find that the quality of the cards will go up when student realize their cards are being scrutinized by the whole class!

Start by moving the timeline marker found 20,000 years. As a class, go through each organism placed on the island the previous week, and determine from the information on the back of the card which populations will have died out or survived based on their habitat needs. For example, if a Striped Coral Fish made its way to the island, and it needs algae for food and coral for habitat, but there is no algae or coral on the poster yet, this animal will swim elsewhere or perish. Any organism that does not have what it needs should be removed and placed back into the hat. You may find that none of the cards placed on the island survived the first 20,000 years. That is OK; island colonization is a slow process! Have students place a few more cards on the island. Then assign more cards for homework.

Sessions 5, etc. throughout the year (15 minutes each)

Each week, remove any cards from the previous week that don't have what they need to survive on the island, and have the students add a few more cards. Assign more cards to be made as homework. These assignments can reflect whatever you are teaching about that week. For example, when teaching about coral reefs, assign students 2 cards of coral reef organisms, and one choice. Or, when teaching about pollination, make sure students put pollinators in the hat. Keep an eye on what is on the island and what seems to be missing, and change your card assignments to fill in the gaps. You'll find that students will automatically start putting in organisms they are learning about in class for their "choice" cards.

Final Week (Coincides with ecosystem and/or biodiversity lessons; 30 minutes)

In front of the class, take cards down and place them on two energy pyramids drawn on the board: one for the marine and one for the terrestrial ecosystem. Have the students tell you which organisms are primary producers, herbivores, carnivores, and decomposers. There will be some species that are part of both the terrestrial and marine ecosystems and they should be placed between the two pyramids. Decide as a group if these are well-balanced ecosystems. There should be primary producers, herbivores, and omnivores or carnivores.

This is a good time to discuss **biodiversity** and how it changes over time. Our Island had very low biodiversity at the beginning, but it increased as time went by. Islands with high biodiversity are more able to survive disease, natural disasters, etc. For example, an island with high diversity of trees would be more **resilient** to an introduced tree fungus, as most funguses only infect a few species. Maintaining high biodiversity is one reason we protect endangered species.

Lesson Extensions:

A variety of life and physical science principles can be taught in the context of Our Island. Here are some possible lesson extensions:

Natural selection: select an organism from the board and draw out a lineage on the board showing a slight change in body over time to make the organism more **adapted** to island life. This can be tied to genetics lessons, island giantism, insular dwarfism, endemism, etc.

Invasive species: if you notice an organism on the island without natural predators, and/or no competition for food, photocopy it several times and add these to the island. You can remove a few other species to demonstrate how invasive species can dominate an ecosystem. You'll probably find that students will add organisms to the hat that specifically target this species.

Coral formation: once coral has established itself on the island, gradually create a coral reef on the submerged island edges. The *BBC's Blue Planet series: Coral Seas* illustrates coral formation beautifully.

Natural Disasters: Add some natural disasters or diseases to the hat! Demonstrate how this could cause some of the animals on the island to go extinct or adapt due to the drastic environmental change.

Biogeography and Speciation: Add another, brand new island next to the first one. Note: animals from the original island will be more likely to colonize the second island, so you could photo-copy these organisms multiple times and place them into the hat; and seabirds and swimming organisms may be able to swim over immediately. You will soon have two different ecosystems with some overlap between the two. This would create examples of population divergence and speciation! Darwin's Finches, by David Lack, discusses speciation by volcanic island divergence.

Erosion: The concept of erosion can be reinforced by slowly shrinking the edges of the island and creating canyons around the creeks. Note: island shrinking occurs when the volcanic activity is no longer actively adding material to the island. Older volcanic islands are *smaller* than younger ones, due to erosion.

Literature and Math extensions: Add a creative writing component by having the students keep a journal or write the story of the island. Have the students graph populations and monitor changing island shape.

Reflection:

The Our Island simulation is reminiscent of many of the SIM type computer games kids often play. Also, middle school and high school students are very motivated by peer approval, so the quality of work on the cards was high without much prodding. Students who rarely showed interested in doing extra work were motivated to create extra cards for extra credit. Also, biological phenomenon seen on television often cropped up on the cards, or in discussions about Our Island, giving students an opportunity to share their knowledge with the class.

Resources:

"Surtsey." The Surtsey Research Society. Web. http://www.surtsey.is/index_eng.htm Active March 15, 2011.

"Understanding Evolution." University of California Museum of Paleontology and the National Center for Science. Web. http://evolution.berkeley.edu Active March 15, 2011.

National Committee on Science Education Standards and Assessment; National Research Council (1995) *National Science Education Standards*. Washington, D. C: National Academy Press.

Lack, D. (1947). *Darwin's Finches: En Essay on the General Biological Theory of Evolution.* Cambridge: University Press.

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