Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Disaster Cycles

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Narrative

We are living in a time when our educational system is driven by standardized and norm-referenced testing; however, the population of students we are teaching is anything but standardized. Students differ in ability, learning style, and cultural backgrounds. We often neglect subjects and areas of study because they are not tested. Unfortunately, there are many students who will be doomed to failure if we continue to teach to the tests. Not all students have strengths in the areas of literacy and mathematics. A child, who continues to struggle in reading, will struggle in everything else until we empower them by giving them an area in which they can succeed.

Although I have not been teaching long, I doubt that I will ever forget a struggling reader that was in my second grade class last year. This student was becoming frustrated with reading and with school in general because he was not feeling success in the classroom. In early May, when I started to teach a science unit about life cycles, his attitude and self-confidence changed completely. Science was an area that he could feel successful in. At the end of the year he represented our class at the school's learning fair. The student, who just two months earlier, was ready to drop out of school at the age of nine, was able to clearly articulate his new learning. Others were so impressed that no one at the learning fair could stop talking about this little boy and his wealth of knowledge about life cycles. Because he was given this opportunity, he was able to succeed in other areas of the curriculum and is now on grade level in reading. For many students, success lies in science, social studies, music, and the arts.

My goal for this unit is to enable the students in my class to be more successful in reading and writing by giving them an area of expertise in science. Children are fascinated by earth science. Many of the students that I work with have not even been outside their own neighborhood, and when they realize that the world is immense beyond their comprehension, they immediately want to soak up as much understanding about our engaging earth as their second grade minds can contain.

Overview

This unit, designed for second graders, is intended to teach students about natural disasters while building upon their learning from a second grade science unit on life cycles. I have chosen content within the topic that can be viewed as cycles: the hydrolgic cycle, hurricane seasons, the tectonic cycle, and the recovery cycle.

This unit can easily be adapted for use in grades one through four. It is meant to provide teachers with the content area knowledge necessary to teach a unit on natural disasters, and some practical resources for conveying that knowledge to elementary school students.

The Hydrologic Cycle

Before students can really understand storms, their schema has to include some knowledge of how the earth's hydrologic cycle works. The hydrologic cycle includes not only the evaporation and condensation of the earth's water supply to form precipitation, but also the energy source by which the hydrologic system is fueled: the sun.

In order to understand the hydrologic cycle, we first must examine the energy source: the sun. The sun provides $1.7x10^{17}$ watts of power to the earth each year (Herring). The temperature is warmer at the equator and cooler at the poles because the equator is exposed to more direct sunlight. Some heat is absorbed by the earth but the most heat is held in our planet's oceans. What can not be contained is emitted back into space. The air is not able to hold much heat at all. When the earth's atmosphere is letting out as much energy as it is taking in, the heat budget is balanced. If the earth is absorbing more or less heat then the atmosphere is letting back out into space, the global temperature will be rising or falling slightly (Herring).

During the day, the sun warms the earth. As the earth's temperature increases, water turns from the liquid state to vapor in the process called evaporation. 90% of evaporation occurs from bodies of water on the earth including oceans, lakes, rivers, and frozen water such as ice and snow. The other 10% evaporates from the leaves of plants in a process called transpiration (US Department of the Interior and US Geological Survey, 2006). When water evaporates, it rises into the atmosphere in a process called convection. Convection is the effect of warmer matter rising and cooler matter sinking. Water vapor is swept up into the atmosphere in warm air currents that are rising.

Once the water vapor rises and cools, it condenses. Condensation is the reverse of evaporation. The temperature of our atmosphere gradually cools from the ground through the troposphere. The vapor continues to rise until it reaches an area of the atmosphere where it can cool. When it does, the vapor turns back to the liquid state in the form of water droplets; this is what forms clouds. Water droplets are also in the air itself, but clouds are groupings of water particles that are large enough to see. Eventually, when the clouds become heavy with water droplets, they are no longer able to be held up, and fall to the earth in the form of precipitation.

The precipitation that falls to the earth causes erosion. Rocks are broken down by water. Heavy rainfall and

storms can cause rivers, lakes, and the ocean to overflow their banks causing erosion on the shores. The earth is constantly reshaping itself through erosion.

Then, the cycle starts over again.

Hurricane Season

Hurricanes originate from warm tropical and sub tropical ocean climates where the water is warm. It is warm in these places all year, but there are slight seasonal changes that contribute to the formation of hurricanes. In the winter season, the days are warm and the nights can be cooler. Because of the cooling temperatures, the ocean water begins to cool as well. In the spring when the temperatures begin to increase, the water temperatures rise, and by summer, create ideal conditions for the formation of hurricanes.

The water cycle and the sun's energy both contribute to the "birth" of a hurricane. Hurricanes form over warm tropical waters. When sea water is at least 80 degrees Fahrenheit and the air is hot and humid it rises into cooler levels of the troposphere. When this occurs, and hot humid air continues to be pumped into the troposphere, tall storm clouds begin to form, the same way they do in a thunderstorms. When the water rises into areas of lower pressure, it condenses and precipitation falls. This is called a tropical disturbance.

Winds are always spinning because of the Coriolis effect. Warm air rises and tries to move to cooler climates which are in the northern hemisphere at the North Pole, and in the southern hemisphere at the South Pole. The winds are deflected by the spinning of the earth on its axis. This causes them to turn to the right or left, depending on the hemisphere. The faster the winds are moving, the faster they spin. This is what causes the spiraling wind patterns in a hurricane.

As the winds pick up speed, the storms begin to come together and spin around an area in the center of the storms. The disturbance begins to turn into a tropical depression. The warm ocean winds spiral upwards in the convection process. As the water vapor condenses into water droplets, energy is released in the form of heat, which boosts the warm rising air and causes the storm to gain strength.

A storm comes to full maturity as a hurricane if the winds reach about 74 miles per hour (Abbott, 2004). When this happens, the winds and clouds begin to spiral faster because of the Coriolis effect; the eye of the storm is formed. The eye is a cylinder at the center of the storm that acts almost like an axis from which the rest of the storm spins. The cool heavy air falls through the cylindrical eye and the warm water vapor and condensed droplets spiral up around the eye. The eye of the storm is calm, because the hurricane is spinning around it with the greatest force happening just along the edge of the eye: the eye wall.

When the hurricane is above water it gains fuel from the moist warm air above the water. The warmer the water is, the larger the storm. The storm slows when it hits land, because there is less water vapor to draw in. Eventually, the storm reaches an area such as land or cooler ocean waters, where it can no longer draw up warm air from the lower levels of the troposphere and the hurricane dissipates.

Storms continue this way until the heat of the summer fades and makes way for winter air that cools the water, usually in November. The cycle begins again in the late spring when the water temperatures begin to

rise again.

The Tectonic Cycle

Plate tectonics is the base for many natural disasters. The energy released from inside the earth can cause earthquakes and volcanic activity. Below our feet, there is a constant cycle of tectonic plate activity.

There are three layers within our earth: the Crust, on which we live; the mantle, just below the crust; and the core, at the center. The core is very dense and balanced on top of it is a less dense mantle. The mantle is about 2,900-km (1,800-mi) thick and made up of two parts, the Asthenosphere and the Lithosphere (Abbott, 2004). The Asthenosphere is deeper, weak, and ductile. The Lithosphere is settled atop the Asthenosphere and it is colder and stronger. The entire mantle is fluid. It is solid, but when exposed to pressure over a long period of time, it is able to flow and deform slowly because of its very high viscosity. The top layer of our planet is called the crust. It is hard and brittle.

The plates that make up the earth's crust and lithosphere are always moving and changing, and it is at the plates' boundaries where the most fierce disasters occur. The cooling mantle is the energy source for plate tectonics. The plates float on the viscous rock of the mantle until it becomes too heavy and begins to sink. Because the mantle is viscous and the crust is hard and brittle, when too much stress from the movement of the mantle is built up against the crust, it breaks causing earthquakes and volcanoes.

As they move, plates traveling in opposite directions rub against one another. The edges of the plates cause friction and this creates fairly large earthquakes. These are called transform faults. An example of this type of fault is the San Andreas Fault in California. Divergence zones are places where plates are moving away from each other. At these points there are often mild earthquakes, and volcanoes that occur where hot magma flows up through the weakened areas of crust in the spreading center. These types of faults are most often found at the ocean floor. In a subduction zone, there are two tectonic plates that are colliding. When one plate is colder and heavier than the other, the heavy plate begins to sink underneath the lighter plate and conforms back into the denser mantle. This causes much friction which can trigger the largest of all earthquakes.

When plates converge, it causes stress on the rock; the stress builds and builds until the stress can no longer be supported by the rock. That is the breaking point at which earthquakes occur. After the earthquake, plates continue their constant movement until they again meet a point of resistance where they start to build up stress again.

Over 80% of earth's volcanic activity occurs in spreading centers underwater. At these points, tectonic plates move apart and mama flows up to the surface where it is cooled by the ocean's waters. Subduction fault volcanoes do not erupt as often, but they are more violent. As a subducting plate is sinking into the earth's asthenosphere water and sediments remain on the plate. When the water lowers the melting point of the rock, it can be partially melted as it passes down towards the asthenosphere. Because of convection, plumes of magma rise up back towards the crust. When too much stress is built up against the rock, it causes an explosive volcanic eruption to release the pressure. After the eruption, the volcano may remain dormant for hundreds of years until enough stress is built up to cause another dangerous eruption Abbott, 2004).

The Recovery Cycle

Disasters such as hurricanes, earthquakes, and volcanoes cause massive damage and destruction. If the disaster occurs in a city or town, houses and buildings can be damaged or destroyed, highways and roads may become impassable, and the economy often suffers. In nature, earthquakes, hurricanes, and the floods often associated with them can destroy animal habitats and create a break in the food chain when plants are uprooted and killed. Whether natural disasters occur in a city, or in a forest, there can often be a long recovery cycle that is different for each disaster.

In nature, disaster recovery is a natural process. It can be a long process, but one that most often occurs in nature without the aid of civilization. Hurricanes can cause flooding and wind damage that destroys trees and animal habitats. Volcanoes can also cause damage. Trees animal habitats and ecosystems are burned or covered in volcanic matter. Slowly, life begins to return to disaster sites.

After a volcanic eruption, there is an area in the immediate vicinity of the volcano that is for the most part completely destroyed. It is singed; it may be covered with cooling lava and pyroclastic flows, or suffocated under volcanic ash. In an area further away from the volcano, life continues as normal.

Once the eruption is over and the damage has been done, the recovery cycle begins. It is important to note that recovery cycles can be different because of the area affected and the nature of the disaster. Some insects that live underground survive the eruption. Soon, spiders and birds return to the area to feed on these insects. Seeds are spread by the animals and by wind. Volcanic matter can sustain plant life, and as it begins to break down into sand through erosion, plants begin to take root. It is the smaller plants, such as grass and moss that grow back first. Then larger plants and trees begin to grow. Once the plants begin to sprout, the animals return to their homes because there is now food for them to sustain their life cycles. Depending on the density of the area, it can take forests hundreds of years to fully recover from a volcanic eruption. (del Moral & Grishin, 1999)

Floods from hurricanes or other storms can cause rivers, and oceans to overflow their banks and flow into the surrounding area. Hurricanes leave areas of low pressure at the surface of the ocean when they pass. In this area of low pressure, the wind pushes the water up into a swell called a storm surge. Storm surges cause the greatest amount of damage during a hurricane. These overflows could cause algae, which are usually beneficial, to become overgrown. Algae can block out sunlight and deplete oxygen levels causing the deaths of many plants and animals. It can also destroy habitats and breading grounds of animals that thrive on the banks (Wroble, 2003).

Once the water levels recede back to normal, the flow of water to the ocean and the hydrologic cycle cleanse the waters and in a short period of time, usually two to three months, the water returns to its normal chemistry, plants re-grow, and animals return (Wroble, 2003). The recovery process can be longer if the flooding occurs near a city, or area where the floods can pick up man made pollutants.

Recovery in populated areas is much different and must be initiated by society. The more populated an area is, the more difficult and expensive the recovery efforts are. Immediate responses include quick construction of emergency medical facilities, creation of shelters, and shipments of food and clean water to be provided to the victims. The actual rebuilding can take years depending on the affected area and the economy. Debris must be cleared, buildings and businesses need to be repaired and rebuilt, and people either decide to

rebuild, or relocate. The economy in the area is often in crisis until businesses are back up and running.

In modern times we have resources to help protect us from natural disasters. To protect us from floods and storm surges, structures are built to keep water out of residential and business areas. There are also many different tools used to predict the time, location, and severity of natural disasters. Because of our knowledge, we are often able to evacuate people in order to keep them safe during disasters. This makes the recovery cycle somewhat easier because there are survivors that can rebuild.

In ancient times, some civilizations never recovered from disasters. We are able to evacuate people because of tools and technology used to predict disasters; and although a long process, we can rebuild cities. Prior to these modern developments, people were not often warned of the arrival of disasters and they were not prepared.

Pompeii is a city in Italy situated directly above a subduction fault. Today, it is clear to us that this may not be a safe place to live and people can choose to reside there or not to. We also are able to detect warning signs that would warn us of a possible eruption. The people of Pompeii; however, were not aware of an impending disaster in 79AD. The volcanic eruption of Mount Vesuvius covered the city in volcanic rock and ash. Pompeii was just a small part of the vast Roman Empire, so the Roman civilization was able to continue to thrive and grow. The Minoans however were not so fortunate. The Minoan society on the island of Santorini was practically wiped out completely by a series of natural disasters including the volcanic eruption of Mt. Krakatau, earthquakes, and a tsunami; this lead to the downfall of the entire civilization circa 1470BC (del Moral & Grishin, 1999) . Scientists and historians are just beginning to learn about the Minoans because of underwater excavations of the ruins.

Classroom activities

The information presented in this unit can be taught in any number of ways. The following is a possible scope and sequence, and examples of lessons that could be taught during the unit.

Scope and Sequence

Week one: The Hydrologic Cycle

Week two: Hurricanes

Week three: Plate Tectonics (including volcanoes and earthquakes)

Week four: The recovery cycle

Possible Extensions

The history of natural disasters

Cultural studies of the Roman and Minoan cultures

The Water Cycle Activities

There are many activities that can be done to help children understand the water cycle. Two that I have chosen to include are a demonstration of how the water cycle works, and an experiment to test how long it takes water to evaporate. The first activity is meant to be done when explaining the water cycle to the children as a demonstration. The second activity is an experiment that can be used as a culminating activity in which the students can apply what they have learned about the water cycle. The second activity, and any writing done for it, can also be used as an informal assessment tool.

Water Cycle Activity 1

This experiment should be done during or after teaching students about the water cycle. It will give them a concrete example and a visual model of evaporation and condensation.

Goals

This activity will help students to understand the water cycle using a visual model.

Materials

A small cup

Plastic wrap

Water

Procedure

1. The teacher will fill the cup with water and cover it with plastic wrap.
2. The cup will be placed in a sunny spot (inside or outside).
3. After a while students will begin to notices small water droplets on the sides of the cup and on the plastic wrap on the top. This may take several hours depending on the weather so plan to set up the experiment and finish it at a later time.
4. The teacher will explain that we can't see the water in the air in the cup because it has turned into vapor, but when it reaches the top of the cup it cools on the plastic wrap and turns back to water droplets. The plastic wrap works in a way that is similar to our atmosphere, keeping water in and helping it to cool and condense. Students will be able to watch as water droplets move to the same area of the plastic wrap and drop. This is condensation and precipitation.

5. Students will draw conclusions in their science journals about what is happening with the cups and why.

Water Cycle Activity 2

This activity can be done as a culminating experiment for the water cycle portion of this unit. The results can be used to assess students' understanding of the concepts presented in this part of the unit.

Goals

Students will follow and become familiar with the scientific process.

Students will create and test a hypothesis.

Students will draw a conclusion based on the results of an experiment.

Materials

Plastic cups (3 per group)

Science journals (1 per child)

Measuring cups

Water

Plastic wrap

Markers

Elastic bands

Procedure

1. Students will pour a half of a cup of water into each plastic cup they will measure the depth of the water using a ruler, and mark the water level on the side of the cup.
2. The students will put one of their cups in the shade, one cup in the sun, and one they will cover

with plastic wrap and an elastic band.
3. The teacher will pose questions for students to write in their science journals: What do you think will happen to the water in each of the cups and why? Which cup of water do you think will evaporate the fastest and why?
4. Students will make predictions and write a hypothesis statement that includes which cup of water they think will evaporate the fastest.
5. Each day, students will measure the water in each of the cups, and record their data and observations in their science journal.
6. After a few weeks, the students will record their data in a graph and work together to draw conclusions about evaporation from the data that they have collected.
7. Groups will be given a poster board and asked to create a display of their information including a short explanation of the water cycle, their hypothesis, their data, and their conclusion.

Hurricane Activity

In my experience, children are fascinated and terrified by hurricanes. They love to learn about how these monster storms are formed and what to do if one happens upon their neighborhoods. This activity is based in reading comprehension to help children understand how hurricanes begin and develop.

Goals

Students will gain an understanding for how a hurricane if formed.

Students will visualize while listening to a text.

Students will demonstrate their understanding of hurricanes in piece of writing.

Materials

Chart paper

Markers

Writing paper

Book: *The Magic School Bus Inside a Hurricane*

Procedure

1. Prior to teaching the lesson, the teacher will record the following hurricane cycle in a circle (with illustrations if possible) on chart paper

1st Ocean water warms up during the summer.

2nd The water evaporates and condenses to form clouds.

3rd The clouds become bigger and taller as they collect more energy from the warm water. (tropical disturbance)

4th The winds begin to spin around the center of the storm. (tropical depression)

5th The winds reach 74 miles per hour and the storm becomes a hurricane.

6th There can be many hurricanes in a season.

7th When summer is over, the waters cool down and there are no more hurricanes again until summer.

2. The teacher will explain this chart to the class.

3. The teacher will read aloud *The Magic School Bus: Inside a Hurricane.*

The goal while reading will be for the students to picture themselves within the cycle of a hurricane.

4. When the teacher has finished reading, the students will share what they had pictured.

5. Students will write a narrative story using the following writing prompt: Pretend that you are a droplet of water in the ocean off the coast of Florida. Write a story explaining your journey through a hurricane.

**Note: in order to accommodate for differences in writing ability, you may choose to allow some children to dictate their stories, or to create a picture book to tell their story instead. This activity is mainly about understanding the science concept and less about writing skills.

Recovery Cycle Activity

Goals

Students will compare and contrast the recovery cycle in nature, to the way that civilization recovers after a disaster.

Materials

The book *Nature Recovers*

Chart paper

Markers

Photos of damage from disasters

Procedure

1. The teacher will divide the class into small groups and give each group photographs of natural disasters and damage from natural disasters. You can find these by doing an image search on the Yahoo search engine or by going to any of the newspaper archive sites listed in the resource section of this unit http://www.earthquakearchive.com/Home.aspx., http://www.thehurricanearchive.com/Home.aspx. http://www.tornadoarchive.com/Home.aspx .
2. The teacher will allow students time to look over the photographs and discus them.
3. The students will brainstorm a list of things that these people need to do to begin the recovery cycle.
4. Each group of students will present their pictures and their lists to the class.
5. While the students are presenting, the teacher will generate a class list of things that need to be done to recover from a disaster.
6. The teacher will read aloud the book *Nature Recovers.*
7. The students will discus the differences between the way nature recovers and how people recover.
8. Each student will create a Venn diagram that shows the differences and similarities between nature's recovery cycle and civilization's recovery cycle.

**Note: in order to differentiate instruction, you may have some students work in groups, draw pictures, or dictate instead of writing.

Possible Extensions

Write a newspaper article to match one of the disaster photographs; write a caption for one of the disaster photographs; write a poem pretending you were involved in one of the disasters in the photographs; create a T chart, on one side explain the recovery cycle for a forest, on the other side explain the recovery cycle for a city.

Implementing District Standards

The topics and lessons in this unit relate to the following New Haven science content standards.

Performance Standard 1.2: Students will understand the process of scientific inquiry.

Performance Standard 2.3: Students will understand the fundamental concepts of the transfer of energy.

Performance Standard 6.4: Students will recognize fundamental concepts about changes in the environment and the effects of environmental change on the earth and its resources.

Student Reading List

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Resources

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