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Bradford Elementary School
Circuits, Cycles and Circles: Sustainability Across the Curriculum

This is a year-long unit on sustainability. We made the decision to do a year long focus on sustainability rather than a focused one month study because we anticipated the year long focus having a stronger, lasting impact on the students. By integrating discussions of sustainability across the curriculum we provided students with connections between our units of study and the choices they make and how these impact the world. The theme of "circuits, cycles and circles" is used as a lens to help students see that cycles are all around us and everything is connected and cyclical in form.

Essential Questions:

What is sustainability?
How does the stream change over time and how do humans impact the stream?
What are the impacts of idling and what are alternatives ?
How is electricity created?
What can I do to conserve energy?
How much energy does our school use?
How can I reduce my water footprint?
What are renewable energy sources and how do these work?
What are people in my community doing to be more sustainable?
How can my choices impact the world?

Vermont GLE	Assessment
S5-6:48 Students demonstrate their understanding of Processes and Change over Time within Earth Systems by diagramming, labeling and explaining the process of the water cycle (e.g., evaporation, precipitation, run-off).	Creating a map of water cycle and water molecule story
S5-6:49 Students demonstrate their understanding of processes and change within natural resources by identifying examples of good and poor management of natural resources and explaining how overpopulation of living things can degrade an environment due to increased use of resources.	Ongoing discussions Final stream study & Evaluation of Science Notebook Renewable Energy Report Final website
S5-6: 50 Students demonstrate their understanding why and how natural resources are managed by explaining the positive and/or negative consequences of human practices on Vermont's natural/agricultural resources.	Ongoing discussions Final Website
S5-6:1 Students demonstrate their understanding of SCIENTIFIC QUESTIONING by identifying multiple variables that affect a system and using the variables to generate experimental questions that include cause and effect relationships.	Evaluation of student notebooks in which students record daily observations and questions regarding their stream visits. Throughout the year, students will visit their stream site and make observations and ask questions about their site.
S 5-6: 2 Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by providing an explanation that is reasonable in terms of available evidence.	Evaluation of student notebooks and final stream study. In the spring they will develop a research question about their stream site and make a hypothesis.
S5-6:3 Students demonstrate their understanding of EXPERIMENTAL DESIGN by… •Writing a plan related to the question and prediction that includes: a. A list of materials needed that specifies quantities (e.g., 250 ml water). b. A procedure that lists significant steps sequentially and describes which variable will be manipulated or changed and which variables will remain the same ("Fair Test"). c. An appropriate format for recording data.	Evaluation of student notebooks and final stream study. Students will write a plan and their procedure of testing their research question.

Vermont GLE	Assessment
S5-6:4 Students demonstrate their ability to CONDUCT EXPERIMENTS by… • Choosing appropriate measurements for the task and measuring accurately. • Collecting data and recording accurate and complete data from multiple trials. • Drawing scientifically: a. Selecting an appropriate perspective (e.g., cross section, top view, side view) and recording precise proportions.	Evaluation of student notebooks and final stream study. Students will collect data based on their research question and present their data and draw conclusions.
S5-6:24 Students demonstrate their understanding of Electrical Energy by… - Exploring, describing and explaining the behavior of charged objects (static electricity) in terms of charges and equilibrium.	Evaluation of student notebook Class discussions
S5-6:25 Students demonstrate their understanding of Magnetism by… - Identifying real world objects that demonstrate and utilize a magnetic force field acting over a distance. AND - Distinguishing between objects affected by magnetic force and objects affected by other non-contact forces, using evidence to explain this principle.	Evaluation of student notebook Class discussions
S5-6:26 Students demonstrate their understanding of Electromagnetic Forces by… Exploring and explaining devices that demonstrate the magnetic effects of electricity and the electric effects of moving magnets.	Evaluation of student notebook Class discussions

Activities to Support Learning Targets

As an interdisciplinary unit sometimes the lessons in this unit were taught within the context of Science class, and other times they are taught specifically on their own in a block of time once a week. The various activities that I listed here cover all spectrums in which we have covered sustainability. They do not exist in lesson plan form, rather they are presented as brief summaries of the activities that we did across the curriculum to build an understanding of sustainability.

Throughout this unit we focused on several topics: ecology (ecosystems), local foods, idling, electricity, renewable & nonrenewable energy sources, solar power, and the water cycle (conservation of water).

Identification of cycles

Over the summer we sent a letter to incoming 5th grade students and families. We asked them to identify something that they do every season and connected these in four bubbles. The first week of school we shared what we had recorded in our bubbles and connected this to cycles through a discussion about yearly activities. We wanted students to be thinking about their cycles and how they relate to their life. After school began we all shared our cycles and discussed commonalities and the cyclical nature of life.

What is sustainability?

To get students thinking about sustainability I showed them a jar of jewels that represented the earth's resources. I told them that these were the only jewels that there were but as I walked around the room they could take as many out as they wanted. I instructed them that I would be putting one jewel back in every 10 seconds or so. As I walked around some students grabbed handfuls of jewels while others only took one or two. When all students had had a chance to choose jewels out of the jar, there were very few jewels remaining and I asked students what would happen if we continued this. They knew that there wouldn't be any left so we tried it, and sure enough, there were no jewels left. We tried it a second time and students were much more conscious of the jewels that remained in the container. Some students only took one and many students didn't take any at all. I wanted to illustrate to students that when we take more than we need, there isn't enough for everybody. Once students had a solid understanding that this was being *unsustainable*, they wrote their own definition of sustainability to share with the class. Some students needed support in coming up with the definition and I guided them with the fact that resources are limited and we should make conscious choices, and we should live within our limits.

List of sustainable activities

After determining the definition of sustainability, students were ready to move on to identify activities or concepts that were sustainable. This classroom discussion was guided but students were able to come up with recycling, local foods, more walking-less driving, compost, reducing etc.

Great Kapok Tree

To kick off our ecosystem unit, I read *The Great Kapok Tree*. Through the reading of this story students could come up with their own definition of an ecosystem. It also planted the seed that students should have compassion towards the environment and that resources are not endless.

Food Chain/Food Web

Each student was given a card that had a producer, consumer or decomposer on it. We used yarn to illustrate how these organisms were connected through the food chain. The goal of this activity was to have students understand how organisms are interconnected within an ecosystem.

Oh Deer-

We played the game *Oh Deer* to illustrate to students the concepts of carrying capacity and limiting factors. See Project Wild.

Wright's Mountain Field Trip

We went to a local mountain as a culminating activity in our ecosystem unit. We divided into four stations: Wright's Mountain Hike/Quest, drawing ecosystems/insects, looking at adaptations and life cycles and ponding.

Local Foods

Local food discussions

To begin the local food discussion, we built on student's knowledge of food chains. Students all shared what they had for dinner the previous night and we traced those items of food back to their original location, making sure to illustrate and emphasize the travel of the food (both distance and type of transportation). To begin we chose a food that had traveled a far distance (shrimp) and followed it backwards (plate-->stove-->refrigerator-->car-->store-->delivery truck-->packaging plant-->truck-->docks-->boat--> ocean). We looked at tropical fruits and then focused on a more local ingredient such as eggs and followed them backwards. We used the article *Why Buy Sustainable?* (www.sustainabletable.org) as a baseline for our discussions, after students determined for themselves why buying local is important. The reasons we discussed were: health, tastes better, animals, environment, workers, rural communities, fossil fuels & energy use and saving family farms.

What's your food footprint?

Students took the quiz *What's Your Food Footprint* (www.whatsonyourplateproject.org) to use as a discussion prompt. We discussed each answer and how it might affect the environment.

Harvest dinner preparation

Every year our school hosts a harvest dinner which uses local ingredients as much as possible. This event is open to the public and requires a lot of planning and work by school and community members. Our class was able to jump on board with this project and help prepare for the dinner. We peeled dozens of ears of corn for the corn chowder, picked basil and parsley from the school gardens and peeled potatoes.

Local food map

In preparation for the harvest dinner another group of students used a list of all the ingredients used at the dinner (salt, flour, baking powder etc) and determined where those ingredients came from and then calculated the distance that these ingredients traveled (i.e.: sugar traveled from Brazil to Bradford but the potatoes came from Newbury to Bradford) using a website that tracked distances. We created a display that had a world map, and a Vermont map in which students tagged each ingredient on the map on the place it came from.

Local food baking- pumpkin cookies

As a class recognition for our behavioral system (PBIS) students made pumpkin cookies. The goal was to expose students to a local food and see the joys in baking a healthy but tasty treat.

Idling

Carpenter Masks

To gain an understanding of the exhaust fumes that are emitted from vehicles, we trekked out to the parking lot and placed carpenter masks over a gas and diesel exhaust pipes. Students make predictions about what the masks would look like when we removed them and which mask (gas vs diesel) would show more evidence of exhaust. This experiment really illustrated to students that there are many emissions being released into the atmosphere when a car is running.

Idling

To promote discussions about idling students took the *Smart Kids Don't Idle Quiz*. I whited out the multiple choice options so that students would have to provide their own answers. Each student took this quiz and then we went through it as a group using the questions as talking points/prompts. The quiz can be found at http://www.ikecoalition.org/Schools/Smart_Schools/Index.htm

Idling Video

To help illustrate the points of idling, we watched a video *Idling* Myths. http://www.youtube.com/watch?v=BnpLUitvhFQ

Myths of Idling

We looked at the myths of idling and many students were surprised by these

http://docs.google.com/viewer?a=v&q=cache:zY3wYElTsh8J:www.idlingtoolkit.com/docs/Section3_Links/Idling_Myths.doc+portsmouth+nh+myths+idling&hl=en&gl=us&pid=bl&srcid=ADGEESi0zMVhzEp9Im_bEKOpyQxSEg1QI48NRxYASUZBRb5w52Qztebde8A410MJ2W_FmDrADfucga6qhvaRx6I9c8kwz6v7e9jiq1_iONLnJKezGMk0zI9HHNlW5-y5ZK5nWM3ZTiYn&sig=AHIEtbRfPAtENLAVF648Yb9cSL-AdfOnng

Respond to myths of idling

Students had to respond to comments that people might make about idling. For instance, they would have to come up with a comeback to *Idling warms my engine and car up before I have to go anywhere?*. (If your mom said this, how would you respond to educate her?) Other questions or response prompts included: *Idling is good for my engine, When I restart my car, it uses more gasoline, It doesn't use that much gasoline to idle, I wouldn't really save that much money anyway if I turned my engine off* and *Why should I worry about polluting? Everyone else does it.*

Idling Data

Student volunteers stood in the drop off circle and bus drop off parking lot in the morning before school to observe the amount of idling. Students recorded the date, the time, the vehicle type (car, truck or SUV), whether or not the vehicle idled or not, and if they did idle, used a stopwatch to record the amount of time. All students did not have the opportunity to collect and record data, but we made the collected data accessible to all students to analyze. In Tech lab, with the support of our technology integration teacher, students entered the data into a spreadsheet program and created graphs based on types of vehicles, amount of idling and the times that vehicles did idle.

Environmental Bad Habits

When we returned from winter break we began our year with New Year's Resolutions. Each student wrote a New Year's Resolution in four categories: personal, family& friends, school and an environmental habit. Since writing these resolutions we have continually discussed them and shared with others what we are doing to make them happen. I think that the constant focus and returning to discussions will help students really meet their resolutions.

Students continued to evaluate and rate them self on their environmental habit and then made changes, possibly even changing to a new habit once one is "mastered".

Magnetism and Electricity

VEEP- renewable/nonrenewable energy sources

We had the pleasure of welcoming Ms. Wurzburg from VEEP (Vermont Energy Education Program) into our classroom. She was excellent in kicking off our unit on electricity and magnetism. The first workshop, titled "Electricity and the Environment" introduced what is necessary to create electricity: magnets, coil of wire and movement. The big issue is creating movement- all ways of creating electricity with the exception of solar power are creating movement of the wire. Students have the opportunity to use hand-crank generators and flashlights (creating movement) and then pedal the VEEP Energy Bike to compare the human pedal power needed to light two incandescent lights with the power needed to light two equivalent compact fluorescent lights (CFLs). It takes a lot more work to light the incandescent bulbs!

The second workshop that Ms. Wurzburg led built on the initial understandings of what is required to make electricity- magnet, coil of wire and movement. Students were reminded that the movement necessary to create electricity is difficult to create. They examined wind power, nuclear power, hydro power and solar voltaics. Students then classified energy as renewable or nonrenewable. The session ended with students drawing a house including as many renewable energy sources as possible.

Throughout the magnetism and electricity unit we used a science kit that had been ordered in the past from Carolina Supply. It is the Electric Circuits STC kit that can be found here: http://www.carolinacurriculum.com/STC/Elementary/Electric+Circuits/index.asp
Some of the students guides were used, but not all. The materials in this kit provided great resources for students.

Atoms

To begin our study on electricity and magnetism we first had to start with atoms- the smallest building block of matter. Students needed to understand that an atom is made up of protons, neutrons and electrons because electrons moving around is what creates electricity. Through discussions, diagrams and a Brain POP video we looked at the parts of an atom and discussed the charges of electrons, neutrons and protons.

Magnetism

We began by understanding the concepts of magnetism and discussing the polarity of magnets. Students used the scientific method to determine which objects were magnetic or not. They then made predications about how many washers could be held up by the magnets. Students recorded their observations in their science notebooks.

Static Electricity

We compared the static electricity of several different materials to illustrate that some materials' electrons move more freely than others. This helps students to see that electricity is electrons becoming excited.

Intro to electricity

http://www.videopediaworld.com/video/10065/Electricity-and-Magnetism-Atoms-and-Electrons

Can you light a light bulb with a battery?

Students were given a D battery and a small lightbulb. They had to discover the four ways that they could light the lightbulb.

Building Electric Circuits

After lighting the lightbulb with just the battery, students were given wire to create a circuit. They explored what was necessary to light the bulb.

Lighting lightbulbs and moving motors

Once students could build a simple circuit to light a lightbulb, we then challenged them to light a lightbulb and make the motor spin. Students then pushed themselves to make the lightbulb brighter and the motor spin more powerfully by adding more batteries.

Montshire Museum

A workshop at the Montshire allowed students to have a deeper understanding of electricity. They built parallel circuits and were able to understand the nature of a series circuit and compare this to the real life frustration of the Christmas tree lights not working because one light bulb is out.

School Energy Audit

Students were assigned a certain room in the school to calculate how much money it cost to light the room. We had hoped to look at computer & printer use as well as other electronics, but were only able to determine the amount of electricity used to light the room. We worked with our head of maintenance to learn about which lightbulbs used which wattage. We used the audit from the Green Education Foundation. http://www.greeneducationfoundation.org/index.php?option=com_fjrelated&view=fjrelated&id=596&Itemid=447

Vampire Electronics

We discussed vampire electronics to show students that appliances use electricity even when they are not in use. It is important to show students how *they* can make a difference by unplugging items.
http://videos.howstuffworks.com/discovery/437-green-gadgets-the-kill-a-watt-video.htm

Solar Energy

Solar Panels- Thanks to Jim McCracken's brilliance our school received a $50,000 grant for solar panels. Earlier this winter, the company Solar catcher, with the help of Riverbend, the local technical center, installed solar panels on our roof. These have provided a wonderful learning opportunity for our entire school population. Unfortunately, the best location for these solar panels is on the roof so students will not have the opportunity to see them directly.

Solar Energy

We began by showing a video illustrating how much energy comes from the sun.
http://video.google.com/videoplay?docid=-4265212146969344136#

How does solar power work?

We watched the following video http://www.revermont.org/main/technology/solar/

Then we did an activity in which we simulated photons (energy from the sun) coming down and exciting the electrons that lived in the silica within the solar panel. Some students represented photons and they had a box of raisons to show that they were energy. The students that represented electrons stood in a rectangle that was roped off on the floor. When a photon gave energy to the electron (raisins), that electron was stimulated or excited and this meant they nudged (bumped) the electron standing next to them. This bumping continue around the electrons and created electricity at the end which we represented by turning a flashlight on.

Solar panels

Using small, hand held solar panels students lit lightbulbs and motors. Over the period of several days students used volt meters to explore which angle created the most electricity, how much electricity was necessary to light a light bulb, as well as experimenting with multiple solar panels to increase the voltage.

Wattmetrics

To examine our schools solar panels, the website *Wattmetrics* was installed on computers. We were able to access the data generated by the solar panels and analyze it. The website showed how much of the 10kW system was being used at a time and gave 15 minute intervals of the electricity generated. Students could compare data weekly, monthly or daily. Examining data close up was very interesting because students could really see where there was cloud cover or discuss other reasons that would interfere with collecting sunlight.

Local Field Trip

Students visited several local businesses and homes that are doing their part to live sustainably in Bradford. We went to Aubuchon Hardware and students did a scavenger hunt to find sustainable products that were carried there. Across the street we talked about energy efficient appliances at Perry's Oil. Before lunch at the Colatina Exit, students learned about compost and the benefits that can come for not throwing food scraps out. At the CVPS dam, students were exposed to the inner workings of a local hydro dam. Down the road at

Farmway, the GroSolar representative came and talked about the benefits of solar power and the advantages to being 43% solar. We ended the trip by visiting a local woman, Nancy Mallery (editor of Green Energy Times) that lives off the grid .

Green Energy Times article

Students wrote an article about their sustainability field trip and it was published in the Green Energy Times!

Connection with Riverbend (local tech center)

I developed a lesson plan with the guidance counselor and electrical technology teacher from Riverbend Career and Technology Center. We got together several times and planned this lesson to be a capstone activity for the 5th grade based on what we had covered in the electricity unit. We came up with three stations: interactive "game show like" quiz board, investigating solar panels and meter reading/identifying light bulbs. The seniors in this class were mainly responsible for teaching and helping the 5th graders throughout the lesson. In fact, they had to relearn or be taught some of the information that we had covered in our curriculum and this was exciting for the 5th graders to hear! The quiz board station asked students multiple choice questions and they switched the light switch. If their choice was correct, a noise would sound or a lightbulb would light. At the second station students identified different types of light bulbs (halogen, CFL, fluorescent etc) and then make predications about how many watts they would use. Students looked at the meter to test their predictions. The third station exposed students to large solar panels and students discussed the time of day that would create the most electricity, what direction the solar panels should be facing etc.

Learning Fair

The learning fair is a school wide opportunity for all students in the school to share their learning with the community. The 5th grade was able to share their knowledge of solar power and their exposure to electricity. We placed all of our solar panels and materials on tables and engaged with students, parents and community members about what was happening, as well as challenging them to light the light bulb on their own. To add to our materials, we borrowed the VEEP electricity kit. The larger solar panels in this set really helped to engaged students. We also borrowed the quiz board from Riverbend and students came up with their own questions that they asked visitors to our room. We had solar power stickers that they were able to give out as prizes.

Water Cycle

Water Scavenger Hunt

We went out on the nature trail and found different places that water exists. Students had to find the item the scavenger hunt asked for, and sketch and include several words about it. Students had to find *something that is made of water droplets, water you can hear, two things that store water* etc. See Project Learning Tree for in depth description.

What do we use water for?

We began by identifying all the ways that we use water. Students then predicted how much water they used on a regular basis. I then gave them averages of how much water is used for common activities such as

washing hands, brushing teeth etc. They were very surprised to see how many gallons of water they use on a regular basis.

How much water can we use?

Using an activity from *Project Learning Tree*, we looked at a gallon of water which represented all of the water in the world. We then took out water that wasn't fresh, water that was frozen in ice caps, water that we couldn't access etc and were left with 1 teaspoon or so of water from the entire gallon that represents the water we as humans can use.

Review of water cycle

Students were familiar with the water cycle but we reviewed it briefly to make sure they understood how water changes forms and moves from location to location. As a morning meeting activity students created a small poster of the water cycle.

Water Cycle Dice Game

This game illustrates to students the journey that a water molecule takes. Each students represent a water molecule and they stand at a sign representing one location of water in the water cycle(glaciers, clouds etc) and then roll the dice to show the possibility of where they might go from there. Students kept track of their journey (river, cloud, groundwater, ocean, ocean, ocean,) and then wrote a story in the first person as if they were that water molecule. The stories came out great and the humor in them was super.

VINS Water Fair

We had the opportunity to go to the VINS water fair where students were rotate between several stations and solidify their learning of water and ways to conserve. They watched a play on the water cycle, examined 100 empty gallons of milk that represented how much water the average American uses daily, pedaled a bike to power a water hose, looked at a model of ground water and saw some examples of what could happen when people do not have clean water.

Ongoing

Stream visits

Throughout the year students visited their stream site that is in the woods on the school's property. We began this early in the fall and continued it throughout the spring. Students made observations at their site about the changes that were occurring through the seasons and asked questions that they were curious about. We introduced new materials to keep things exciting, such as colored pencils, magnifying glass, thermometer etc. Every day after students made general observations, they were given focus- notice the speed of the water, or what is on the rocks, tree bark etc.

Science Notebooks

Students make observations, draw, sketch, ask questions in their Science notebooks. It provides one location for all of their thinking to be.

Outside appreciation

Through our behavioral system, PBIS, classes earn recognitions. Our class is able to vote on what they want to do for their recognitions and often times they choose outside appreciation. This is a time that students

can go outside into the woods-in a specific area- and do whatever they want. Students build forts, try to dam the river, sit on stumps, create a lean too- the possibilities are endless. The goal of this activity is for students to appreciate outside so that they can see the importance in making an effort to conserve it.

Our class uses cloth napkins during events so that we are not generating the waste of plastic napkins.

I have built up a collection of ceramic mugs for students to use rather than plastic cups which get thrown away daily.

Culminating projects

Renewable vs Nonrenewable Reports

Students chose a renewable energy source (hydro power, solar power, ocean power, geothermal energy, wind power) and conducted research on their energy source and then wrote a report on this energy source.

How to Live Sustainably

Students in 5th grade in our district must write a "how to" or procedure piece. Students created a powerpoint presentation in which they selected 3 ways to live sustainably (reduce water footprint, recycle etc) and then had to give 5 steps on how to do that. These presentations provided a final culminating activity for students.

Creation of Website

This project existed as a culmination of everything that we have discussed in 5th grade as related to sustainability. I worked with our technology integration specialist to determine and figure out what the best program for this activity is. Students worked in pairs, under the guidance of a "webmaster" or editor (student leader) to create a subset of the Bradford Elementary School (www.beschool.org) page. This website is sustainable in itself and exists as a service learning project because it shares our knowledge and findings with the public.

Resources

Project Wild

Project Wet

Project Seasons

Project Learning Tree

Animal Inquiries Teacher's Guide, Montshire Museum

The following websites provided me with information. I did not necessarily use projects or lessons from them.

http://www1.eere.energy.gov/education/lessonplans/

http://www.revermont.org/main/technology/wind/

http://www.eia.gov/kids/energy.cfm?page=activities_elementary

http://www.soltrex.com/learn/calculator.cfm

http://energyquest.ca.gov/teachers_resources/index.html

http://www.greeneducationfoundation.org/index.php?option=com_fjrelated&view=fjrelated&id=596&Itemid=447

http://www.wattzon.com/

http://www.energyliteracy.org/energy_101.html

http://podcast.lakelandschools.org/groups/gwes/weblog/99f3d/Pencils__A_Classroom_Commons.html

http://www.pnwboces.org/efs/

http://iwla.org/

http://www.epa.gov/sustainability/index.htm

http://videos.howstuffworks.com/discovery/437-green-gadgets-the-kill-a-watt-video.htm

http://www.vtefs.org/resources/index.html

http://www.fwee.org/walktour/

http://videos.howstuffworks.com/discovery/437-green-gadgets-the-kill-a-watt-video.htm

http://planetgreen.discovery.com/games-quizzes/energy-use-quiz/

http://www.earthteam.net/

http://www.energy-literacy.org/index.html