the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Balancing the Earth's Energy Budget

Grade Level	Middle School 6-8	**Subject**	Physical Science

Objective(s):

The students will map out their local school yard and investigate the temperature of various manmade infrastructures and compare and contrast those with natural vegetation, water sources and other sites of their choice. From this information they will apply the concept of the Earth's Energy Budget and in particular locate heat islands and natural cooling systems.

From this experience students will redesign a selected a site on their campus to reduce the temperature of a heat island.

Students may assess the redesign for environmental impact and if possible build their best design.

Infrastructure-our basic building structures

Earth's Energy Budget describes the balance between the sun's incoming energy as it is absorbed or reflected by the earth's surfaces and then returned to space. This balance maintains the temperature of our planet.
http://www.nc-climate.ncsu.edu/edu/k12/.eeb

Heat island – usually found in an urban setting, heat islands are spaces with higher surface and atmospheric temperatures compared with their surroundings.
http://www.epa.gov/heatisland/about/index.htm

SOL Addressed:

6.3 The student will investigate and understand the role of solar energy in driving most natural processes within the atmosphere, the hydrosphere, and on Earth's surface. Key concepts include
- a) Earth's energy budget;
- b) the role of radiation and convection in the distribution of energy;

LS.11 The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include
- a) environmental issues.

PS.7 The student will investigate and understand temperature scales, heat, and thermal energy transfer. Key concepts include
- a) Celsius and Kelvin temperature scales and absolute zero
- C) conduction, convection, and radiation; and
- D) applications of thermal energy transfer.

Common Core Standards:

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

<table>
<tr><td>Materials Needed Per Class of 30

and

Prior Knowledge</td><td colspan="2">Anticipatory: (5 min)
Introduction: (10 min)
Guided Practice and Independent Practice:
Thermometers, Infrared laser thermometer, paper, colored pencils, clip boards
1. Students should be familiar with methods of heat transfer: radiation, convection, conduction and their influence within the ecosystem. Be able to identify the specific heat of substances, especially water, in maintaining temperatures on our planet.
2. Define Earth's Energy Budget. Investigate and discuss the influence difference surfaces, especially water and plants, have on the heating and cooling of the earth's surface. Apply these concepts to the development of heat islands.</td></tr>
<tr><td>Ways to differentiate this lesson plan</td><td colspan="2">• EXTENSION for Higher Level Learner
After researching designs and examples, gather materials from local sources to create their own solution.
• MODIFICATIONS
Provide examples for the group to create their solution. Choose one solution together and provide materials for teams to participate in building parts of the solution.</td></tr>
<tr><td>Introduction/ Anticipatory Set</td><td>Anticipatory Set: Go outside to a hot place to sit with the students. Then move to a cooler spot. Which space would be described as a heat island?

Questions to ask students: Why are some areas of the school yard warmer than others?

How do water and plants play a role in heating or cooling the earth? Watch the movie clip together to see examples of how water and plants cool the earth.
http://www.orionmagazine.org/index.php/audio-video/item/audio_slide_show_next-gen_water_infrastructure
In what ways could we change the way we build infrastructure so it functions with nature instead of in opposition? Watch the movie clip together.
http://www.orionmagazine.org/index.php/audio-video/item/slide_show_the_art_of_infrastructure/
Why do people have concerns about the climate of our planet?</td><td>Introduction:
Look around the school yard and identify where cool and hot spots would be found. Use think, pair, share and discuss what is different about the spaces.

Infrastructure is the way we build things. By looking at creative ways to change the way we build, we can incorporate features that naturally slow down and filter water, reduce high temperature areas or heat islands, provide a home for wildlife and create beauty in our world.</td></tr>
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Guided Practice	1. Use various methods to measure and map the temperature of various surfaces within the school yard; asphalt, concrete, grass, gravel, mulch, water sources, metal roof, green roof plants, gardens, trees, wetlands, forest, a trellis, solar panels, surfaces of cars, furniture and equipment, others on location. 2. Overlay map with vegetation and sources of water including storm water run-off. 3. Mark the compass directions on the map, make a key and use colored pencils. 4. In a discussion, compare and contrast the variables which determine differences in temperature within the area of study (color, solar orientation and angle, specific heat of materials, water and water flow, types of plants and landscape features, others). 5. Research basic information and identify examples of heat islands and how vegetation, green roofs and other solutions modify infrastructure to reduce temperatures. Research how water solutions are also being used. Look for unique ways to redesign the infrastructure in a creative way to moderate the temperature of an area. **6.** Identify local sites that are good examples of redesigned infrastructure and reflect cultural aesthetics or reflect a sense of place.
Independent Practice	**How can we change the infrastructure in our schoolyard to reduce temperatures using natural vegetation and harvested water**? 1. As a team, students will design an aesthetically pleasing solution to lower the temperature of selected heat island(s) in the schoolyard incorporating natural vegetation and local water sources if possible. 2. If possible students will incorporate upcycled or refurbished materials from local sources to build the design. 3. The design should demonstrate an understanding of ecosystem dynamics. 4. Have teams apply an environmental impact assessment to their design. Identify favorable and adverse effects of their design on local flora, fauna, people, soil, water, air, cultural heritage to the best of their knowledge.
Closure (Summary of Lesson)	1. Present and evaluate solutions from the groups and identify environmental impact. 2. Select the best solution(s) from those presented and construct the design. 3. Continue to monitor and adjust design(s). **4.** Discuss other sites in the local area that could be redesigned to reduce heat islands.
CEED Building Application/ Sensor Data	http://ceed.frco.k12.va.us/how-it-works http://dashboard.intellergy.us/ceed/index.php Discuss the use of solar orientation, the overhang, green roof, trellis and rainwater collection in designing the building and maintaining temperature control, while providing aesthetic infrastructure. Compare temperature readings of roof top water collection and daily temperatures.
Assessment	• Map of school yard with temperature readings, water and vegetation sources, compass and key, in color • Performance rubric to assess the team design of site on campus including environmental impact • Self assessment of student participation and their team in the project