Urban Heat Island Effect

Grade: Middle School

Next Generation Science Standards:

- **Science and Engineering Practices: Constructing Explanations and Designing Solutions:** Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
- **DCI: ESS3.D: Global Climate Change** Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)
- **Cross Cutting Concept: Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-4)

Working towards Performance Expectation: MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Investigation 1: Surface Temperature

This investigation takes place outside with access to grass and pavement.

Instructional Sequence:

Warm-up prompt: If it were a hot summer day, where would you go outside to cool off?

Lead students in a class discussion about the warm-up prompt. Guide students towards noticing how hot it is on a basketball court, versus under a tree at the park. Ask students why they think that is: why is it so much cooler on the grass at a park, than on pavement? Tell students that we will be exploring this through an experiment today. Explain to students that we will be measuring the temperature on pavement, and compare it to the temperature in a grassy area. Provide students with the lab report for this experiment. Ask students to define what the independent and dependent variables will be for the experiment. Have students work with the lab partner to formulate the Question, Hypothesis, and Procedure, and complete these sections on their lab report. Once students have finished, take a moment to review these sections as a class, and discuss the procedure they will all be using.

Next, ask students to note any observations they may have while they set-up their experiment. Students will use an infrared thermometer to find the temperature of different types of ground covering: tell students they should all test asphalt, and grass, and then find a third type of

ground to test as well. Have students record the temperature of each ground covering, performing two separate trials.

Back in the classroom, have students compile data from their trials. Students will then calculate the average temperature of each type of ground covering. Next, they will work with their lab partner to analyze their data, and write out their analysis and conclusion on their lab report.

Have students switch out one partner with a group near them so they have a new partner. Each new partner will then take a few moments to share their findings, and their conclusion. Afterwards, students can move back into their original partner pairings, and make any modifications to their conclusions that they feel is necessary.

Accommodations: Having students work in teacher-selected partnerships allows the teacher to match students in a way that they are both being supported.

Assessment: Students understanding of temperature variance on different surfaces will be assessed by their written explanations on their lab report sheet.

Lab Report

Name _____ Date _____ Class _____

Title: The effect of IV on DV?	
Question: What is the effect of IV on DV?	
Hypothesis: If____ then ____ because _____	
Materials:	
Procedure: Single actions taken to conduct the experiment that are numbered in sequential order.	

<table>
<tr><td>Data:</td><td>
<table>
<tr><td>Ground type:</td><td>Asphalt</td><td>Grass</td><td></td></tr>
<tr><td>Temperature trial 1:</td><td></td><td></td><td></td></tr>
<tr><td>Temperature trial 2:</td><td></td><td></td><td></td></tr>
<tr><td>Average temperature (from both trials):</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Data analysis:
Describe in words what your data shows. Use calculations to compare results.</td><td></td></tr>
<tr><td>Conclusion
Discuss whether your hypothesis was accepted or rejected.</td><td></td></tr>
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Investigation 2: Real World Connection

Instructional Sequence:

Begin the lesson by reviewing the previous activity with students:

- What were your findings from the experiment that we did?
- What do you think this might tell you about summers in different types of places? What would the temperature be like in a rural area with lots of fields? What about an urban area with lots of pavement?
- Are these surfaces/environments naturally occurring? Where do they come from?

Let students know that we will be exploring what different surfaces do to the temperatures in different environments. Show students the following video as an introduction to Urban Heat Islands: http://www.ei.lehigh.edu/learners/luc/heat_island.mov Lead students in a discussion about Urban Heat Islands and humans' impacts on the environment:

- What is the Urban Heat Island effect?
- What causes cities to be hotter than rural areas? *(humans, urbanization, pavement)*
- What effects does this have on cities?
- How have human activities impacted the surface temperature of certain areas?

Next, students will work with their partner to read through "Urban Heat Islands" (http://teacherstryscience.org/sites/default/files/uploads/lessonplan/resources/urban_heat_islands.pdf) and complete the "Urban Heat Island Graph Analysis." After reading the article, students will be able to complete the "Claim, Evidence, Reasoning" organizer where they are asked to use their data from the previous experiment to state a claim while providing evidence, and using information from the article. Provide each pair of students with a piece of chart paper and a marker.

Next, students will create a poster explaining their Claim using Evidence and Reasoning from their experiment and the article. Students will then circulate around the room in a Gallery Walk, looking at one another's posters, and leaving feedback or questions for their peers using Post-It notes. Afterwards, give students a few minutes to debrief with their partner, and see if they would like to incorporate more into their explanation to make it stronger.

To conclude, have students write their answer to an Exit Slip: How have human activities altered surface temperature in their environment?

Accommodations: Having students work in teacher-selected partnerships allows the teacher to match students in a way that they are both being supported.

Assessment: Students will be assessed on their understanding of the urban heat island effect using their Claims, Evidence, and Reasoning worksheet, Gallery Walk poster, and Exit Slip.

Urban Heat Island Graph Analysis

	Late afternoon temperature
Rural	
Suburban Residential	
Commercial	
Down Town	
Urban Residential	
Park	
Suburban residential	
Rural Farmland	

1. How does the temperature downtown relate to the surrounding areas?

2. What causes the increase of temperature in the city center?

3. What human actions have impacted the temperature of their environment?

4. What is significant about the temperatures near parks?

5. Why does the temperature around the park show a decrease in temperature?

Claim - Evidence - Reasoning: Surface Temperatures

State your claim: How can human activities/construction impact surface temperatures?	
Provide Evidence: How did your data from the surface temperature experiment support your claim?	
Scientific Reasoning: What information does the article provide to explain this phenomenon?	

Investigation 3: Climate Change and the City

Instructional Sequence:

Review the previous two investigations with students, and ask them: "If we are forecasted to have more heat waves, how might this impact residents of cities? What might be some possible issues? What might be some potential solutions?"

Tell students that they will be researching future impacts of climate change, and looking at how that relates to the urban heat island effect. They will then go on to design, build and test a roof design to lessen the Urban Heat Island effect. Students will work with their partner to read articles (below) about climatologists predictions for the impact climate change will have on the number of hot weather events that will take place.

Bring the class back together for a whole class discussion. Guide the class towards defining the problem behind the Urban Heat Island effect, why it's important to people, and potential solutions.

Tell students that they will be given a cardboard shoebox that represents a building, the lid acting as the roof. *(Possible materials for their design challenge may include: black/white paint, plastic wrap, foil, wax paper, pebbles, fish tank gravel, cotton balls, soil, live plants, newspaper, marbles, filter material, fabric, stockings, etc.)* Ask students to define the word "constraints," and have them think-pair-share some of the constraints for their roof design *(i.e. time, materials, etc.)*.

Students should work with their partner/small group to begin planning their design using the planning sheet. Students will define the problem they are trying to solve, the constraints involved, their design idea, and how they will measure the effectiveness of their design.

Provide students with additional class time to continue to design, test, and iterate on the design of their roof.

Article suggestions:

- http://www.huffingtonpost.com/2012/08/15/urban-heat-island-effect-climate-change_n_1778949.html
- http://www.washingtonpost.com/news/energy-environment/wp/2015/04/27/study-global-warming-has-already-dramatically-upped-the-odds-of-extreme-heat-events/
- http://www.sciencetimes.com/articles/4969/20150327/climate-change-and-the-urban-heat-island-in-californias-central-valley.htm
- http://www.scientificamerican.com/article/heat-islands-cook-u-s-cities-faster-than-ever

Assessment: Students' Claim, Evidence, and Reasoning graphic organizer. Students' evaluation of their peers can be reviewed to provide you with a holistic view of students' understandings, and their presentation/speaking abilities.

Technology Extension: Students in New York City can explore local temperature projections, and also locate solutions (white roofs, green roofs, etc.) using the CUSP Map: www.cuspmap.org/NYC

Name _____ Date _____ Class_____
Group members: _____

Reducing the Urban Heat Island - Roof Design Challenge

Problem:	Constraints:

Step 1: Design layers: What household/classroom material will you use?

Step 2: What outcome do you hope to achieve with your design? How will you measure the effectiveness of your design?

Step 3: Results and Next Steps