

5E Lesson Plan	
<b>Lesson for Grade 6</b>  <b>Taught over the course of several periods.</b>	<b>Urban Heat Island Effect: Why is NYC so hot, and how can we cool it down?</b>  <b>There are three accompanying documents:</b> <b>1.</b> Urban Heat Islands: Why is NYC so hot and how can we cool it down IMAGES pptx <b>2.</b> Absorption and Reflection Experiment Worksheet <b>3.</b> Courtyard Design Challenge Worksheet
<b>NGSS Standards for Middle School</b>	<p>MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.</p> <p>MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.</p> <p>MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.</p> <p>MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.</p> <p>MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.</p> <p>MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.</p>

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<b>Goals</b>	<ul style="list-style-type: none"><li>-Students will be able to explain the terms albedo and heat island.</li><li>-Students will be able explain that reflective surfaces and increased vegetation can have a cooling effect on an urban area.</li><li>-Students will support their claims with data evidence.</li></ul>
<b>Engage</b> The purpose for the ENGAGE stage is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.	<p>Show several thermal images of NYC landmarks (see attached images) and ask, "What do you observe about these images? What structures can you identify in these images?"</p> <p>Student responses may range from observation of color variation, color patterns, the color and temperature gradient along the right side, guesses of structures and locations.</p> <p>Reveal the next slide, which shows the photographs alongside their thermal images. These locations will be familiar to students in NYC.</p> <p>Tell the students that these photographs, and colorful images were taken during the summer, by a visual artist and researcher named, Nickolay Lamm. He used a special thermal camera to take the colorful images.</p> <p>Ask, "What do you think a <b>thermal</b> image is? Think about another word that we know, that has the same root, <b>therm</b>ometer. What could a thermal image be revealing?" (<i>Therm</i> is the Greek root for heat) Thermal imaging cameras can "see" the heat radiating from objects and creates a colored pattern to show the measurement of the heat.</p> <p>Ask, "What indicates to us that these are thermal images, and not just colorful prints?"</p> <p>Focus students' attention to the temperature gradient on the right side of the images. This shows degrees Fahrenheit from coolest in purple, to the hottest temperatures in pink. This key, gives us information that will help us make sense of these images.</p>

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	<p>Ask, "Which areas of each image are the hottest? Which areas are the coolest?" Have students come up the SmartBoard to point out examples of each.</p> <p>Ask, "What can you infer about the temperature of different materials in an urban landscape?"</p> <p>Have several students share their ideas. Encourage students to connect their thinking to examples from the photographs and thermal images on the board.</p> <p>Students should infer that areas that have natural elements such as water and trees, tend to be cooler than structures made of asphalt, cement, and some metals. Students might also notice that elements are that are reflective or light colored (some sides of the freedom tower, water, white stripes of crosswalk) are cooler, than elements that are dark colored or non-reflective.</p>
<p><b>Explore</b> The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.</p>	<p>Explain that the students will now be exploring how different surfaces are affected by solar energy. Students will be conducting an experiment on the absorption and reflection of light energy. As they make their hypotheses about the experiment, students may want to make reference to the thermal images, or other personal experiences that they have had, i.e. light and dark clothing, seats of a car, time in a park. See "Reflection and Absorption of Light Energy Experiment".</p>
<p><b>Explain</b> The purpose for the EXPLAIN stage is to provide students with an opportunity to communicate what they have learned so far and figure out what it means.</p>	<p>Read the article: <a href="https://climatekids.nasa.gov/heat-islands/">https://climatekids.nasa.gov/heat-islands/</a> Discuss, when a material absorbs solar radiation, or light energy, some of that energy is converted into heat energy. The more light that is absorbed, the more heat that is produced. When solar radiation, or light energy, is reflected by objects, less energy is absorbed by the object, therefore the less is converted to heat energy. The material remains cooler.</p> <p>Albedo is a term used to indicate how well a surface reflects solar energy. Surfaces with low albedo absorb most of the incoming energy. A surface with</p>

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	<p>high albedo reflects most of the incoming energy. Show Interactive Roof Reflectance Map: <a href="http://albedomap.lbl.gov/#1">http://albedomap.lbl.gov/#1</a> and click on a “sample cool roof,” and a “sample warm roof.” Read the information and observe the roofs.</p> <p>In an urban landscape, there are so many surfaces with low albedo, that it can raise the temperature of the city to be higher than the surrounding areas. This is called the Urban Heat Island Effect. Play the NASA Urban Heat Island Video: <a href="https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=10699">https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=10699</a></p> <p>Ask, “What are some of the factors in creating a heat island?” The materials that are used to create the landscape, the amount of vegetation, the population size, and the location of the city.</p> <p>Ask, “Why is urban heat island effect a concern?” Elicit responses such as it can cause health issues, comfort of living issues, more electricity needed to cool buildings which means more greenhouse gases emitted into the atmosphere.</p> <p>Ask, “Is there any time when it might be advantageous for cities to be warmer?” This might be true in winter when less energy is needed to clear ice and snow from the roads and roofs.</p>
<p><b>Evaluate</b> The purpose for the EVALUATION stage is for both students and teachers to determine how much learning and understanding has taken place.</p>	<p>Show the tweet from the LA Department of Public Works, Bureau of Street Services.</p> <p>Ask, “What questions might the residents of Los Angeles have about this message?” “Why are they painting the streets white? What is cool pavement?”</p> <p>The students will be writing a short statement to help the residents of LA understand <b>why</b> city planners would choose to paint the streets white, and what the phrase “cool pavement” might be referring to. Use data from your lab experiment to support your statement. (See attached Image)</p> <p>Next the students will compare the two images of New York City. Central Park is</p>

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	<p>marked for their reference. One image shows surface temperature, while the other shows vegetation. Ask, "What do you observe about the temperature in areas that have more vegetation, versus the temperature in areas that have less vegetation? Write an explanation for how this relates to the data you collected during the experiment."</p>
<p><b>Explore</b> The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.</p>	<p>You will be re-designing our school courtyard to try to create a space that has a high albedo. You will be working in teams, and using the engineering design process to create a prototype.</p> <p>Describe the design challenge: How might we create a courtyard design that has a high albedo and will stay as cool as possible on hot sunny days? See the Design Challenge Worksheet.</p> <p>The courtyard is also a city park, so it is important that there are a few activities that can still take place on the surface, handball, foursquare and basketball. Describe the constraints as outlined on the Design Challenge Worksheet.</p>
<p><b>Elaborate/Extend</b> The purpose for the EXTEND stage is to allow students to use their new knowledge and continue to explore its implications.</p>	<p>Check out your apartment building. Ask you super what kind of roof it has...is it a cool roof or a warm roof? If your building has a courtyard or playground, what are the surfaces like? Do they have a high or low albedo? How might your own building make changes that could help combat the Urban Heat Island effect in NYC?</p>
<p><b>Evaluate</b> The purpose for the EVALUATION stage is for both students and teachers to determine how much learning and understanding has taken place.</p>	<p>Groups should share their designs and test results with the class. After each sharing, there will be a time for the group to receive questions and comments.</p> <ol style="list-style-type: none"> <li>1. Describe how your courtyard design performed compared to the control.</li> <li>2. How did you incorporate in the basketball, handball, and foursquare courts?</li> <li>3. Which design elements do you think had the largest impact on the final temperature? Explain how you could test this.</li> <li>4. What worked well in your design?</li> </ol>

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	5. What improvements could be made to your courtyard design to further lower the temperature?

**Bibliography:**

Heat Island Community Actions Database. (2017, May 30). Retrieved from

<https://www.epa.gov/heat-islands/heat-island-community-actions-database>

Heat Island Compendium. (2017, May 09). Retrieved from

<https://www.epa.gov/heat-islands/heat-island-compendium>

Hot Roofs, Cool Roofs: An interactive and comparative map of roof reflectance for 5 California cities. (n.d.).

Retrieved from <http://albedomap.lbl.gov/losangeles.html>

Lawrence Berkley National Laboratory

NASA | Urban Heat Islands. (2010, December 10). Retrieved from <https://youtu.be/lnBO4vX82Fs>

Plumer, B. (2018, July 25). 5 Ways to Keep Cities Cooler During Heat Waves. Retrieved from

<https://nyti.ms/2OevUr5>

Serafini, S. (2015, October 13). Bright Is The New Black: New York Roofs Go Cool. Retrieved from

<https://www.nasa.gov/feature/bright-is-the-new-black-new-york-roofs-go-cool>

Services, L. S. (2017, May 20). Today Los Angeles became the first place in California to install a cool pavement treatment on a public street! Ten deg cooler on summer aft [pic.twitter.com/UkwgosotyR](http://pic.twitter.com/UkwgosotyR).

Retrieved from <https://twitter.com/BSSLosAngeles/status/865989081590710272>

What is an Urban Heat Island? (n.d.). Retrieved from <https://climatekids.nasa.gov/heat-islands/>

Why LA Streets Are Being Painted White. (2017, September 12). Retrieved from

<https://youtu.be/ileU--wuOd0>

