NCSE
National Center for Science Education

Activity Training Guide

Cool Cities

An Engineering Design Challenge

Cool Cities

Overview

Many cities act as urban heat islands, significantly warmer than their surrounding areas due to human activities. Our warming climate will only make these cities hotter, leading to intense heat waves and lowered quality of life. Cool Cities allows participants to explore the ways cities can mitigate the heat island effect while taking into account urban planning.

Learning Goals

1. Have students follow the engineering design process to create a sustainable city to combat the heat island effect.
2. Combine real-world science and equity issues for a nuanced discussion about the future of city living.

Materials

Things we Provide:

- 2 ice cube trays to form the urban grid
- Asphalt cubes to build streets (7 total)
- Sand cubes to go under buildings. Some have holes for plants. (14 total)
- Turkey baster for making lakes and ponds
- 3 types of buildings
- Wood: 1-3 stories (10 wood bldgs total)
- Glass: 1-4 stories (8 glass bldgs total)
- Steel: 1-3 stories (4 or 5 steel bldgs total)
- Urban adventure cards
- Temperature gun

Things you will need:

- 1 liter of water (inside a sturdy container that will not topple)
- Leafy twigs to represent plants
- Heat Source - Options include:
    - Hairdryer - Best for the under 8 crowd
    - Space Heater - May use too much power if working in an outdoor/communal space
    - Heat Lamp - Probably the best for heating, but can easily cause burns
- Play Money (From Rising Tides kit or hand drawn. Can also be kept track of on whiteboard)

Set-up

1. Set up the activity by placing the two ice cube trays beside each other and unpacking all the building supplies. Make sure you keep the heat source on your side of the table where it cannot be reached
2. **DETERMINE YOUR MAX TEMPERATURE**. This will vary depending on air temperature, humidity, heat source, and set up. Fill a 3*3 square with all asphalt blocks and heat it for 3 minutes consistently. Let it cool for 1 minute and assess the temperature. We suggest setting the fail temperature at 5-10 degrees cooler than this (or at 105, whichever is cooler).

Procedure

Short Form

1. When visitors approach, explain that they are going to try to build a city with real building materials that can withstand the heat. Tell them that they need to first build the ground (with asphalt, sand or water) then they need to figure out how to put 200 people in their city.
2. Start by telling them they need a road in their city. They can put a road wherever they want, but it most go from one side of their city to the other. They can also put asphalt in other places.
3. Then ask them where they want features of water to be. Help them use the turkey baster to fill in some squares with water.
4. Finally, fill in the rest of the squares with sand. If they want the area to be a park, make sure they are using a sand block with a hole in the top.
5. Once the ground is built, encourage them to build a cityscape that can house 200 people, 5 people per floor of building (so a 2 story building houses 10 people, a 4 story building houses 20). Buildings cannot be stacked. Buildings can be placed atop sand and asphalt that isn't designated as road.
6. Once the city is built, heat it up. We suggest the following heating protocol
7. Use the temperature gun to get base readings.
8. Heat the city from above for 2 minutes.
9. Allow city to cool for 45 seconds.
10. Measure max temperatures across the city.
11. If temperature rises above MAX TEMP, then they need to try again.

Long Form

1. Follow set-up above. You should pre-place the road dividing the city into 2 3*6 halves. We will call each half a city. Split your group into 2 or 4 teams.
2. Distribute $200 to each team. Tell them that need to fit 100 people into each quadrant. Also tell them that for each 100 people, they will need to have one parking lot (a non-road asphalt cube). Distribute the cost and profit sheet.

3. Allow the groups to build their cities. Heat them up and test their design (see testing protocol above)
4. Distribute profits to each team ($20+ profits from each cube) . Have each group draw a card and change their design to fit these new parameters. Any changes must be paid for.
5. Repeat the heating and card drawing process until a team goes bankrupt or brings their city over the max temperature
6. Discuss effective architectural solutions for cities. Bring in climate change, growing populations, and equity problems in modern cities.

Modifications and Guiding Questions

1. For short interactions, particularly with younger visitors, we suggest pre-building some or all of the city. They can heat, test and modify without needing to start from scratch.
2. For older visitors, the drop-in activity can be modified to focus on real-life city problems. Some examples:
    a. This design works, but we need to make space for 100 more residents. How might we do this and still maintain a green city?
    b. The city has decided that the areas around the edges are suburbs and buildings cannot be higher than one block. How can you still maintain a green city?
3. Make sure you focus on success - we want to encourage creative solutions while respecting real world constraints, but we also want to celebrate everyone's success
4. With large families, you will often need to divide and delegate tasks. Small children (<5) can be godzilla with a hairdryer, elementary school kids can put blocks in but may have problems taking blocks out (especially with water), and older kids can use fine motor skills to insert plants into sand. Starting with the division of these tasks will mean that no one feels like a failure by not being able to do them.

Further Resources

- Heat Island Effect
- Cities and Climate Change: An Urgent Agenda

NGSS Standards

3-5-ETS1-2 Engineering Design

Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
Performance Expectation
Grade: 3-5

HS-ESS3-4 Earth and Human Activity

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
Performance Expectation
Grade: High School (9-12)