Marshall University Sustainability Department

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Green Roofs

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OBJECTIVES

Students will hypothesize and test an experiment simulating the effects of green roofs.

LESSON PARAMETERS

1. **Key Terms** - green roofs, water conservation, energy transfer, urban heat island effect, stormwater runoff
2. **Group Size** - groups of 3 to 5 students; applicable for a class ranging from 3 to 30 students
3. **Grade Levels** - 3rd- 12th
4. **Duration** - one 45 minute session
5. **Setting** - indoors and outdoors
6. **Disciplines** - Science, Mathematics, Art, Engineering, Environmental Education, Technology, Architecture
7. **Learning Techniques -**
    a. Discussion
    b. Hands-On
    c. Group-based Collaboration
    d. Interdisciplinary
    e. Activity-based
    f. Real-world application
    g. Critical Thinking
    h. Goal-oriented

GREEN CONNECTIONS

- **Connections to Home and Community -** Students will realize the effects of green roofs and hopefully be inspired to share such innovations with their own homes and communities to reap the environmental benefits.
- **Sustainable Perspectives -**
    - Energy Efficiency
    - Green roofs
    - Water conservation
    - Eco-friendly homes

LESSON SUMMARY

Students will begin this lesson with an experiment to engage them in learning. If possible, the class should be split into three groups, with two shoe boxes, a thermometer, and a reflector lamp (or the sun if it's a nice, sunny day) per group. They will be challenged to hypothesize and test how different scenarios affect the temperature in each box by comparing the initial and final temperatures of their shoeboxes. Group one will test the temperature differences between a shoebox in direct light and a shoebox that is shaded by a plant. Group two will test the temperature differences between a shoebox painted white (or covered in aluminum foil) and a shoebox painted black (or covered in black paper); both placed in direct light. Group three will test the temperature differences between a painted white (or covered in aluminum foil) shoebox shaded by a plant and a black (or covered in black paper) shoebox shaded by a plant. Once each groups' experiments are set up, students will leave their boxes for ten to fifteen minutes (depending on time availability).

During these ten to fifteen minutes, the class will reconvene and discuss their hypotheses and identify the variables in the experiment. Then the instructor will transition the conversation into green roofs, asking the class the discussion questions. The students will also receive an informational handout about green roofs to guide their learning and discussion. They will be challenged to explain how the experiment is related to green roofs. Once time is up, the groups will return to their experiments to record a final temperature from their boxes. They must calculate the change in temperature and compare such values to the other groups. Then they will clean up the experiments and discuss the results with the class. They shall indicate how such results relate to green roofs.

ACTIVATING STRATEGY

Students will be engaged right away with an experiment. They will simulate the effects of green roofs through three different scenarios for shoeboxes.

LESSON DEVELOPMENT

Exploration Lesson - Students will explore green roofs through experimentation. They will participate in active learning as they go through the scientific method to test their hypotheses.	**Explanation Lesson -** Students will gather information during experimentation metacognitively. They will also learn about green roofs from discussion with the class and instructor along with an informational handout.

LESSON ADDITIONS

If time allows, the students may research green roofs online. Optional resources include:

- urban heat island (http://education.nationalgeographic.org/encyclopedia/urban-heat-island/)
- Urban Forests = Cleaner, Cooler Air (https://www.asla.org/sustainablelandscapes/Vid_UrbanForests.html)
- INfographic: Chicago Hot Spot (http://www.pbs.org/newshour/multimedia/green-roofs/)

DISCUSSION QUESTIONS

- What is a green roof?
- Why have green roofs?
- How do you make a green roof?
- How is energy transferred in green roofs

MATERIALS

Physical Materials

- Six shoe boxes (or cardboard boxes)
- Three reflector lamps (or the sun)
- Three potted plants large enough to provide shade for the shoeboxes
- Three thermometers (or just one and the groups may take turns)
- Black paint or black construction paper
- White paint or aluminum foil
- Paintbrushes
- Experiment instruction guide per group
- Green roof informational handout per student from pages one through three from https://www.asla.org/greenroofeducation/pdfs/StudentWorkbook.pdf

RATIONALES

- Next Generation Science Standards
  - 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.
  - HS-ETS1-1- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
  - HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
  - MS-ESS2-4 - Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity

- 21st Century Science Content Standards and Objectives for WV Schools
  - SC.O.6.1.05- cooperate and collaborate to ask questions, design and conduct investigations to find answers and solve problems.
  - SC.O.6.1.10- utilize experimentation to demonstrate scientific processes and thinking skills (e.g., formulating questions, predicting, forming hypotheses, quantifying, or identifying dependent and independent variables).
  - SC.O.ES.2.28- research alternative energy sources and evaluate the ecological, environmental and economic cost-benefit ratio.
  - SC.O.ENV.2.4- evaluate environmental and economic advantages and disadvantages of using nonrenewable and renewable energy.
  - SC.O.8.2.21- relate the conservation of energy theory to energy transformations (e.g., electrical/heat, or mechanical/heat).
  - SC.O.ENV.2.18- identify sources, uses, quality, conservation, and global distribution of water.
  - SC.O.ENV.2.19- create models to show surface and groundwater flows in a local drainage and explain how surface and groundwater are related