




Lesson Plan: *Exploring Permeability and Runoff*

What is a permeable material?

Alignment with STEM Framework

Inventor  Tinkerer  Investigator  Designer 
Altruist 

Overview

In this activity, youth will analyze the permeability of surfaces and how the permeability of pavement can impact the amount of stormwater runoff in an area. In order to do this, they will create a walkable and permeable “pavement” using limited resources and a limited budget. Not only does this introduce youth to the different criteria and constraints that must be considered when designing a technology, it encourages them to think creatively about ways to solve problems in the world around them.

Practice Goals

- Asking questions and defining problems
- Developing and using models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

Content Goals

- What is Permeability?
- What are models?
- How can we use models to solve problems?
- How does the permeability of pavement affect runoff?

Purpose

This activity is intended to encourage youth to assess the impact pavement permeability has on the amount of runoff in an area, as well as explore their ability to create innovative technologies and solutions to environmental problems without negatively impacting the quality of life of the people who live in or visit the area. It also encourages them to think critically about the way that the areas we live in affect the environment around them, and how to reduce our impact through creative and innovative city planning.

Teacher Background Information

This activity focuses on the permeability of pavement as a way to control the amount of runoff produced on roads and walkways. The more permeable the material, the more water that can be absorbed, and vice versa. Roads, parking lots, and walkways can take up large areas - especially in more urban areas and big cities which can make it difficult for stormwater runoff to be absorbed in these areas. More permeable surfaces can be used in some scenarios - such as gravel or dirt walkways - but can be difficult to traverse for motorized vehicles or wheelchair users, depending on the area. Less permeable materials can be easier to traverse, but can trap stormwater runoff on their surfaces. Balancing these two conditions, as well as whatever technological or economic limitations that may be present, can be difficult for city planners when working on roads and walkways.



Affinity Goals



I can act like an **Altruist** by considering how permeable pavements affect individuals who would walk, or drive, on them and how runoff collecting on non-permeable pavements impacts our community .



I can act like a **Designer** by creating solutions to the runoff problems in our walkways and roads that improve our quality of life.



I can act like a **Tinkerer** by creating models and improving them to find better solutions to our target position.



I can act like an **Investigator** by analyzing the different aspects of permeability and walkability that we need to consider to adequately address the issue of runoff.



I can act like an **Inventor** by creating solutions to the runoff problems in our walkways and roads that are innovative and consider practical limitations.

Materials

Time Needed

45 Minutes

- Engineering Design Process poster
- Chart paper and markers
- Included handouts
- Recording materials (notebooks/pencils, phones, etc.)
- 1 yard of cheesecloth
- 1 yard of screen
- 2 wind-up walking toys
- 4 rolls of foil
- 4 spray bottles
- 20 craft foam sheets
- 20 sponges
- 25 felt sheets
- 50 cups, 8 oz.
- 100 cotton balls
- 500 paper clips

Each Small Group

- 1 large foil tray
- 1 small foil tray
- 1 pair of scissors
- 1 ruler

Instructional Sequence

Discuss permeability, paved areas, and runoff

- Direct the youth in a discussion about pavement permeability and how this can impact the walkability and the amount of runoff produced by these areas. Show the youth images of different types of sidewalks, parking lots and roadways and have them brainstorm different solutions to this problem.

Split the youths into pairs and familiarize them with the materials/constraints of the experiment

- Introduce the youth to the materials they will be using during the experiment, and inform them that they will only have \$200 to work with during the project.
- The goal is for youth to create a “paved area” using the materials provided that not only absorbs water, but is also smooth enough to walk or drive on.
- It may be beneficial to youth for the facilitator to provide an example model - choosing a few materials at random to layer and use as their pavement and run the experiment to let them get the hang of things before they get started.

Have youth create and test their pavement:

- After choosing their materials, youth should create their pavement models, layering the different materials and playing around with the different materials available to them to see how permeable they are.
- Once the models are ready, youth can test the permeability and walkability of their pavement by placing their chosen materials in a small tray and placing the small tray into a larger one.
- Test the walkability by sending the wind-up walking toy across the pavement to see if it can walk straight.
- Spray the pavement 20 times with water after determining walkability, and wait 20 seconds to see how much water flows into the bottom pan.
- Pour the infiltrated water into a measuring cup and record the amount of infiltrated water on the provided chart.

Review the initial results

- Have the youth analyze the amount of water that infiltrated their pavement. Are there ways that they can improve their pavements’ walkability or permeability? What sorts of adjustments can they make?

Improve and test the pavement:

- Allow the youth to make changes to their initial designs, using different materials to create better pavements.
- Once their initial designs have been changed, have them test these new designs to see how walkable or permeable their new pavement is, following the same steps as before and recording the results in their charts until they are satisfied or time is up.

Lead a discussion about the experiment

- Guide the youths through a discussion on their thought processes throughout the experiment - was the toy able to walk across their pavement? How much water was able to infiltrate the pavement when certain materials were used? How were they able to improve on their initial designs so that more water could infiltrate the pavement? How were they able to improve on their initial designs so that the toy would be able to walk across the surface more easily?
- Another way to prompt discussion is to show the City Snapshots to the youth and ask them what advice they might give to city planners to develop roads.