Lesson Title	Porosity, Permeability, and Grain Size
Length of Lesson	50 Minutes
Created By	Adam Lenz
Subject	Earth & Space Science
Grade Level	7th Grade
State Standards	1a,d; 4a,b
DOK Level	2,3
DOK Application	Predict, Compare, Hypothesize, Draw Conclusions.
National Standards	Inquiry – recognize the relationship between explanation and evidence Earth & Space Science – Structure of Earth processes, importance of Earth materials.
Graduate Research Element	Porosity and Permeability determine the effectiveness of a reservoir.

Student Learning Goal:

- As part of the Mississippi State 7th grade curriculum students must learn about structure and importance of earth process and earth materials. This lab was designed to examine real-world in a lab setting and also helping them utilize the inquiry and the scientific method. The main goal of the lesson is to teach students make connections between grain size and permeability of different soil types, collect a local soil sample, and hypothesize/test their collected sample.

- The National Standards focus on Earth & Space Science and Inquiry.

Materials Needed (supplies, hand-outs, resources):
Four permeability test columns for each group (22oz transparent plastic bottles, mesh filter, clear plastic cups, 250mL beaker for measuring water), collected sediment of 3 different grain size (gravel, sand, clay), stop watches for each group, graph paper, handouts with blank tables, and PowerPoint presentation.

Lesson Performance Task/Assessment:
The students will use stop watches to record the time it takes a measured volume of water to flow through the porous medium. Then they will collect a local sample and inquire about the "permeability" of the sample by guessing the time it will take for water to flow through the unknown sample (1a, 1d). Afterward, the students will record a time for the new unknown local sample that they have collected and draw conclusions and make connections about the grain size and composition of the new sample.

Lesson Relevance to Performance Task and Students:
This lesson will help student make connections between grain size, porosity, and permeability as well as teaching them about basic groundwater movement in hands on tasks (4a, 4b).

Anticipatory Set/Capture Interest:
After seeing a short explanation of the lab, students will be able to go outside and collect a soil sample for their group and perform the permeability test on their own.

Guided Practice:
The instructor will give a short description about grain size, porosity, and permeability. Then, each student/group will be given a handout with a worksheet and directions for the lab experiment. The instructor will then help students in the lab beginning with the timing of the three provided soil samples, followed by the collection of a soil sample from outside. The instructor will then end the lab with a post-lab discussion to draw conclusions about their experiments, determine if students were correct about their hypotheses, and to examine the further learning practices. This process is a very significant part of my own research because we collect samples to determine if the soil types in our research area are suitable for retaining water for a potential reservoir.

Independent Practice:
In small groups of 3-4, students will be given 3 soil different soil samples from that the instructor has prepared, and a jar for a 4^{th} of which they will collect themselves; make inquiries and comparisons about the permeability of the local (collected) sample. The students will then perform the permeability test in their groups and draw conclusions about their hypothesis regarding the permeability. All data will be recorded on the handout given at the beginning of the class period.

Remediation and/or Enrichment:
Remediation will consist of a closer guided practice with students in smaller groups so that the basic concepts of the lab can be grasped through a more individual, hands-on approach. Enrichment learning will include a guided discussion about groundwater flow, more advanced soil types, and soil properties. Advanced students may be able to grasp concepts about aquifers and sources of water suitable for drinking.

Check(s) for Understanding:
Assessment questions throughout the experiment will help make sure the students understand the concepts of the lab. The instructor will be able to help and guide students

who work more slowly or have difficulty understanding concepts throughout the experiment. Afterward, a short in-class discussion about student's hypotheses and conclusions will help spark interesting and further questions from the students.

- What conclusions can you draw from your results of the soil permeability test?
- What is the relationship between porosity and permeability?
- How could you apply what you learned to develop ideas about groundwater in the real world?

Closure:

- Students will fill out data sheet and answer post-lab questions.
- Students will discuss further examples of permeability and porosity.

Possible Alternate Subject Integrations:

- Earth Science (Groundwater Flow)
- Mathematics (Algebra)

Teacher Notes:

Handouts and should be distributed at appropriate times during the lab so that students are not distracted during the introduction of the experiment. The instructor will need to evaluate students' progress throughout the experiment to manage time and post-lab discussion.

If for some reason the students are not able collect a local sample from nearby the school the instructor may prepare a local sample of which they have collected prior to class, or purchase (possible have donated) a local sample from a home supply store such as Lowes or Home Depot and/or a local contractor, etc.