Arroyo Walk: Increasing Infiltration and Slowing Runoff

Infiltration in the Arroyo Unit, Lesson 5

Lesson Summary: Students will return to the arroyo to look for ways of increasing infiltration, applying what they learned over the course of the week.

Suggested Timing: 1 hour, including walking to and from the arroyo

New Mexico State Standards

Performance Expectation(s):

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

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.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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.

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.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific principles to design an object, tool, process or system. Asking Questions and Defining Problems: Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. Engaging in Argument from Evidence: Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument	ESS3.C: Human Impacts on Earth Systems: Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. ETS1.A: Defining and Delimiting Engineering Problems: The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. ETS1.B: Developing Possible Solutions: There are systematic processes for evaluating solutions with respect to how well they meet	Cause and Effect: Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Influence of Science, Engineering, and Technology on Society and the Natural World: All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

that supports or refutes claims for either explanations or solutions about the natural and designed world. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. Analyzing and Interpreting Data: Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to determine similarities and differences in findings. Developing and Using Models: Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.	the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. ETS1.C: Optimizing the Design Solution: Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.	

Evidence Statements:
- MS-ESS3-3 Evidence Statements
- MS-ETS1-1 Evidence Statements
- MS-ETS1-3 Evidence Statements
- MS-ETS1-4 Evidence Statements

ELA CCSS Connections:
- RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-3)
- RST.6-8.7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-3)

Math CCSS Connections:
- MP.2. Reason abstractly and quantitatively. (MS-ETS1-3)
- 7.EE.3. Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-3)

Content Objectives and Daily Learning Targets	**Objectives**: ● I can explain different ways that erosion can be slowed and infiltration increased.

	● I can implement solutions that help prevent erosion and increase infiltration. ● I can compare and contrast different solutions and evaluate their effectiveness in different situations.
Focus Question	What solutions can be used to improve infiltration in our arroyo?
Language Objectives	● Students can correctly use scientific vocabulary orally and in writing. ● Students can share their thoughts orally.
Vocabulary	● **Aquifer** - an underground layer of permeable rock, rock fractures, or unconsolidated materials that hold water. ● **Impermeable** - not allowing water to pass through. ● **Infiltration** - the downward entry of water into the soil. ● **Groundwater** - water that is found in the cracks and pore space in the rocks or earth materials below the ground. ● **Permeable** - allowing water to pass through. ● **Pump** - noun, a mechanical device using suction or pressure to raise or move water. Verb, force water to move by means of a pump. ● **Runoff** - the flow of water occurring on the ground surface when excess rainwater, stormwater, meltwater, or other sources, can no longer sufficiently rapidly infiltrate in the soil. ● **Surface water** - water that collects or flows on the surface of the ground. ● **Water table** - the level below which the ground is saturated with water. ● **Well** - a shaft sunk into the ground to obtain water or determine the depth of the water table.
Materials	● Science notebooks ● Native grass and wildflower seeds ● Art supplies
Preparation before class	● Buy native seeds
Assessments (Formative/ Summative), Rubrics, Success criteria	● Notes about plants in science journal ● Plan for the arroyo ● Success Criteria ○ Students will be able to come up with reasonable solutions to mitigating erosion using evidence from their explorations.
EL Supports	● Think-pair-share allows students to practice what they want to say before sharing with the whole class. ● Students use drawing and writing to share their thinking.
Culturally Relevant Strategies	● Students are working in small groups, practicing social and academic skills. ● Students are learning about the local environment, helping validate the

	experience of the students.
Special Education Modifications	● Follow student IEP. ● Think-pair-share allows students to practice what they want to say before sharing with the whole class.

Lesson Plan Details

ENGAGE (~10 min):	● Walk to the arroyo. ● Have all the students find a place to sit. Give them 2 minutes to find as many different plant species as possible. Let them know they should not worry about names of the plants but to make distinctions between grasses, plants, bushes, and trees whose root systems will be structured differently.
EXPLORE (~15 min):	● Ask students to assess what types of plants are in the arroyo channel, on the arroyo banks, and on the uplands outside the arroyo channel. There's a good chance that deep rooted shrubs (e.g. chamisa) are in the channel, deep rooted trees (e.g. Siberian elm) are on the banks, and denser patches of grasses around outside the channel. Why would a deeper rooted plant be next to the spot that receives the most water (i.e. the arroyo). ○ The arroyo channel likely has coarse soil textures (think back to the early arroyo walks) which easily drain and don't hold soil moisture between storm events. Thus drought tolerant chamisa with deeper roots and capable of bending during deep flows can be found in the bottom of the arroyo channel. ○ The arroyo banks might have finer soil textures that hold soil moisture, but because they are steep and eroded, the soils are exposed to sunlight and dry out. Thus deep rooted, rigid trees that cannot live in the channel, grow on the channel edges. ○ Fine textured clays and silts outside the arroyo hold water in the upper soil profile between precipitation events and thus can support grasses that cannot tap into deeper soil moisture. ● Ask students to look for evidence of infiltration. What do those areas look like? Have students locate where plants are growing. ● Have them record what they notice using words, maps, and/or diagrams. ● Ask students, are the plants located in the areas with a lot of infiltration? Have students describe the evidence that they observe. ● Ask them to reflect on where water is available to plant roots, and where plant roots help hold the soil.

EXPLAIN (~10 min):	● As a whole group, have students share what they noticed. Look along the banks of the arroyo for examples of plants where the roots are exposed. Have them compare the different types of roots: fibrous versus woody. How effective is each in preventing erosion? ● Discuss how the plants at the bottom of the arroyo are doing and compare this to the banks. Which plants have access to more water?
ELABORATE (~10 min):	● Give students each some grass seed with native wildflowers. Ask them to plant what you gave them, with 3-5 seeds per hole. Holes should be less than ¼ inch deep. ● Ask them to look for places where the seeds might germinate (with water) and help stabilize the loose soils.
EVALUATE (~15 min):	● Have students draw what they imagine the arroyo would be like if it were revegetated and if erosion issues were no longer a problem. Have them include solutions they have learned about through the infiltration and erosion lessons. Ask them to write about what they would do and make their claim based on the evidence they have collected that backs up these recommendations. ● Walk back to the school.

Additional Sources:

- 5 Es of Science Instruction
- 5E Model of Instruction
- ISEC model of lesson sequence