Under Earth by Aleksandra Mizielinska and Daniel Mizielinski

Grade Band: 4-5 STEM Designed Lesson	Literature: Under Earth Aleksandra Mizielinska and Daniel Mizielinski	**Posted**: Maureen Foelkl http://straubenvironmentalcenter.org/

Brief Lesson Description: Scientists and researchers use specific methods and multiple sources of evidence to build ideas and information. Students will investigate root systems. They will examine and design a system that replicates how trees get the materials they need through water.

Essential Questions:

How do external structures support the survival and growth of plants?
How do scientific methods help us understand the structures of living things?
How do living things interact with water?
How do root systems help plants survive in different ecosystems?

Core Vocabulary: External Structures Survival Growth Plants Energy Sunlight Air (carbon dioxide) Water Producer

NGSS Standards

Standard: 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
Standard: 5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
4-LS1-1. and 5-LS1-1. Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Construct an argument with evidence, data, and/or a model.	4-LS1-1. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. 5-LS1-1. Plants acquire their material for growth chiefly from air and water.	4-LS1-1. A system can be described in terms of its components and their interactions. 5-LS1-1. Matter is transported into, out of, and within systems.

Skills, Reasoning and Claims:

4-LS1-1. Students make a claim to be supported about a phenomenon. In the claim, students include the idea that plants and animals have internal and external structures that function together as part of a system to support survival, growth, behavior, and reproduction. Identifying scientific evidence: Students describe the given evidence, including: i. The internal and external structures of selected plants and animals. ii.The primary functions of those structures Evaluating and critiquing evidence: Students determine the strengths and weaknesses of the evidence, including whether the evidence is relevant and sufficient to support a claim about the role of internal and external structures of plants and animals in supporting survival, growth, behavior, and/or reproduction. Reasoning and synthesis: Students use reasoning to connect the relevant and appropriate evidence and construct an argument that includes the idea that plants and animals have structures that, together, support survival, growth, behavior, and/or reproduction. Students describe a

chain of reasoning that includes: i.Internal and external structures serve specific functions within plants and animals (e.g., the heart pumps blood to the body, thorns discourage predators). ii.The functions of internal and external structures can support survival, growth, behavior, and/or reproduction in plants and animals (e.g., the heart pumps blood throughout the body, which allows the entire body access to oxygen and nutrients; thorns prevent predation, which allows the plant to grow and reproduce). iii.Different structures work together as part of a system to support survival, growth, behavior, and/or reproduction (e.g., the heart works with the lungs to carry oxygenated blood throughout the system; thorns protect the plant, allowing reproduction via stamens and pollen to occur).
5-LS1-1. Students identify a given claim to be supported about a given phenomenon. The claim includes the idea that plants acquire the materials they need for growth chiefly from air and water. Identifying scientific evidence: Students describe the given evidence, data, and/or models that support the claim, including evidence of: i. Plant growth over time. ii. Changes in the weight of soil and water within a closed system with a plant, indicating: 1. Soil does not provide most of the material for plant growth (e.g., changes in weight of soil and a plant in a pot over time, hydroponic growth of plants). 2. Plants' inability to grow without water. iii. Plants' inability to grow without air. v. Air is matter (e.g., empty object vs. air filled object). Evaluating and critiquing evidence: Students determine whether the evidence supports the claim, including: i. Whether a particular material (e.g., air, soil) is required for growth of plants. ii. Whether a particular material (e.g., air, soil) may provide sufficient matter to account for an observed increase in weight of a plant during growth. Reasoning and synthesis: Students use reasoning to connect the evidence to support the claim with argumentation. Students describe a chain of reasoning that includes: i. During plant growth in soil, the weight of the soil changes very little over time, whereas the weight of the plant changes a lot. Additionally, some plants can be grown without soil at all. ii. Because some plants don't need soil to grow, and others show increases in plant matter (as measured by weight) but not accompanying decreases in soil matter, the material from soil must not enter the plant in sufficient quantities to be the chief contributor to plant growth. iii. Therefore, plants do not acquire most of the material for growth from soil. iv. A plant cannot grow without water or air. Because both air and water are matter and are transported into the plant system, they can provide the materials plants need for growth. v. Since soil cannot account for the change in weight as a plant grows and since plants take in water and air, both of which could contribute to the increase in weight during plant growth, plant growth must come chiefly from water and air.

Common Core Standards:
ELA/Literacy Reinforcements: (W.4.1) (RI.5.1), (RI.5.9), (W.5.1)
Mathematics (STEM) Reinforcements: (4.G.A.3) MP.2), (MP.4), (MP.5), (5.MD.A.1)

Materials:

- **Under Earth**, Aleksandra Mizielinska and Daniel Mizielinski
- How Deep are the Roots Template
- Tree Roots Template (Blank)
- Live plants in viewing box or photos of plant roots
- Measuring tools, thermometers
- Engineering construction materials (plastic plates, recycled plastic, cardboard, aluminum foil, wax paper, duct tape, sponges, cotton balls, paper toweling, yarn, string, etc.)
- Black pepper
- Scissors
- Science Notebooks
- Pencils, color pencils
- permanent marker
- Water, 500ml per student
- Tablets with internet connection (if available)
- Leaf Snap application (free)
- Time Lapse camera (if available)

LESSON PLAN – 5-E Model

ENGAGE:

Begin with having the students view roots from a variety of trees and plants. Use photos from the sources below. Review the function of roots with students. What are some of the functions of roots in a plant? Have students talk and turn. Record responses on paper creating an on-going anchor chart. Check to make sure that students have adequate background knowledge of how roots absorb water and minerals from the soil, how they anchor plants firmly in the soil and bind soil particles together to help with erosion

Next explain to the students that they will examine three examples of root systems. In their notebooks have them sketch and label each root. You can display photos from the resources below or create a simple viewing boxes from recycled material (http://youreasygarden.com/easy-to-make-root-view-boxes).

Make sure to display examples of the following root modifications and functions

- A tap root is the plant's first root that grows directly from the stem of a plant. Some edible tap roots are the carrot, radish, beet and turnips. Edible roots store food as carbohydrates for the future.
- Fibrous roots are smaller roots that branch out in different directions. They are closer to the surface of the soil instead of going deep.
- Adventitious roots are able to sprout roots from parts of the plant. The Banyan Tree has aerial roots. These roots will come out of the stems. Their function is to grow downward giving the tree extra support.

EXPLORE:

Take students outside with their notebooks. Spy a tall tree. Explore the needs of the tree. Why does this tree continue to grow? What do you notice about the light, temperature, space, water and soil in the area. Review that trees get the materials they need for growth through water and air. Ask them to sketch the tree including the root system. Add labels to estimate height (http://www.saps.org.uk/attachments/article/141/SAPS_How_to_find_the_height_of_a_tree.pdf) and root depth. Propose the question, how does the water from the roots reach the leaves at the crown of the tree? Ask students to talk and turn. Then have them write, I believe the tree has_____ _____ that brings _____from the roots of a _____ to the top of the _____. Have students sketch their understanding of the process.

Return to the classroom and provide additional support for understanding. View a demonstration of how trees transport water from the roots to the leaves https://www.youtube.com/watch?v=9-dicqNoODg Using their sketches from the field and new understanding from the video, the students will construct a working model (30-40 cm height) that demonstrates how trees use internal structures to move water. Their structure must validate and explain their thinking of the process.

When models are completed, place each in a pan with 500ml of water. Add the black pepper in the water to model nutrients. Make observations by measuring the distance the water and pepper have traveled over time. Add drawings and written language to communicate their findings.

At the end of the week, ask students to draw conclusions by writing or presenting their collected data. Ask how they would make improvements to their structure? How would the results change if your model had longer roots? What if your structure were taller? Does shape make a difference? Encourage well defined responses using peer supports. If time allows, have students make changes to their model.

EXPLAIN:

Students will make observations of trees with deep roots on page 16 and 17 from *Under Earth.* Review meter measurement prior to viewing. While sharing the information have students create a bar graph (How Deep are the Roots? attached) from the trees shared. Discuss the root length with the tree's habitat. Why do the roots of some trees go deeper than others? How does climate effect the depth of roots? Might

a Camel Thorn tree grow in our area? Why or why not? What is your reasoning? Prompting students by using agree/disagree statements helps students to connect the evidence to support the claim with argumentation.

Students can research trees in their community. Using the Tree Roots template (blank attached) have pairs of students create a data graph of their findings. Students will begin to make connections to the trees and their root systems in their own backyard.

Compare their findings with the trees from *Under Earth* text and their local trees. How are the trees the same/different in another climate? Ask the learners if a Douglas Fir tree would grow in their area? Would that tree get the support it need to grow? Why or why not?

ELABORATE:

Students can place the root view containers near a light source. Using a permanent marker or tags, measure above and below grown growth over time. Collaborate with student teams to collect growth data and to take photos of their observation (sample of photo project attached). Have students notice a pattern on the date labels. If possible, students could use a time lapse and create a video of their observation. Be sure to cover the root area with dark or thick paper so that the roots avoid light exposure. This is a great visual for students to witness growth over time.

EVALUATE:

Formative Monitoring: Observing, recording and drawing in their field notebooks. Communicating their ideas with peers and teacher.

Summative Assessment : The teacher can use the sketches, the model and the data collected to demonstrate student understanding.

Sources:

Books:

- What Do Roots Do? Kathleen Kudinski, Scholastic Books, 2007.
- Tops and Bottoms, Janet Stevens, Harcourt, New York, 1995

Internet:

- http://arnoldia.arboretum.harvard.edu/pdf/articles/1989-49-4-tree-roots-facts-and-fallacies.pdf Tree roots and systems
- http://www.hellistreeconsultants.co.uk/kbi1000014_tree_root_systems.html Tree root systems
- http://www.npr.org/sections/krulwich/2012/06/21/155508849/how-do-plants-know-which-way-is-up-and-which-way-is-down How roots grow
- http://youreasygarden.com/easy-to-make-root-view-boxes/ Simple way to make a root view box
- http://pbskids.org/plumlanding/educators/activities/roots_and_shoots_ed.html
- http://www.reference4kids.com/plants/types_of_roots.html to investigate a variety of root systems
- http://pbskids.org/plumlanding/educators/activities/roots_and_shoots_ed.html (Lesson modified from this source)
- http://www.saps.org.uk/attachments/article/141/SAPS_How_to_find_the_height_of_a_tree.pdf Height of a tree measurement activity
- http://leafsnap.com/about/ Leaf identification application

Videos

- https://www.youtube.com/watch?v=Qj7_IdQTZBc Adapted from Tops and Bottoms by Janet Stevens
- https://www.youtube.com/watch?v=iFCdAgeMGOA&feature=player_embedded Time lapse

growing of corn

- http://extension.illinois.edu/gpe/case1/c1facts2a.html Interactive site on root function
- http://www.science4all.org/article/the-amazing-physics-of-water-in-trees/ Root systems (for teacher reference only)