Grade: K-2	Topic: Hydroponics	Lesson (Number/Title): Comparing Traditional vs Soilless Gardening

Brief Lesson Description:

Students will create hydroponic wick systems out of upcycled materials in order to compare plants grown without soil to those grown in a more traditional manner.

Performance Expectations:

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Specific Learning Outcomes:

- Students will identify the resources that plants require from their environment in order to survive.
- Students will explain the role of the leaves, stems, and roots in acquiring these resources from the environment.
- Students will compare qualitative and quantitative data to determine which growing method is more effective.

Narrative/Background Information:

Background for Teachers:

This lesson is meant to introduce young students to the concept of hydroponic farming. It is the ultimate goal for students to recognize that soil is not necessary for growing a plant. Students should recognize that plants get the materials they need from light, water, and the air around them and only require trace amounts of other nutrients from the soil (or water) they are growing in. Observations should be made with respect to general plant health, height/width, number of leaves, and amount of water needed to keep them growing. Simple charts or narratives can be created to summarize their findings and to help them compare the two growing methods.

Teachers Preparation:

- Plastic bottles (size of your choosing) should be collected ahead of time, rinsed, and have their labels removed. Retain the caps.
- You should review the attached bill of sale to determine the scope of your participation. If you intend to start from seed, be sure to have all necessary seed starting equipment prior to introducing the lesson.
- You should select a leafy green you would like to experiment with and acquire seeds.
- Seeds should be sewn at least two weeks in advance of implanting them into their wick systems. If you intend to start the soil control group in their own pots, do so at the same time that you prepare the rockwools.
- Any students that handles the rockwools should wear non-latex gloves, protective eye wear, and should avoid shredding the material so that it is not inhaled.
- Designate a spot in your classroom/greenhouse that will provide ample light for your plants or prepare a growing area that will be equipped with indoor grow lights.

Prior Student Knowledge:

- Students should have a basic understanding of experimental design (aka the scientific method).
- Students should be able to identify basic plant anatomy (roots, stems, leaves, flowers).
- Students should be able to make simple measurements.

Science & Engineering Practices:

Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. (K-LS1-1), (2-PS1-2), (K-2-ETS1-3)

Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1)

Analyze data from tests of an object or tool to determine if it works as intended. (2-PS1-2), (K-2-ETS1-3)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. (K-ESS3-3)

Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (K-ESS3-3)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. (1-LS1-1)

Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1)

Disciplinary Core Ideas:

LS1.C: Organization for Matter and Energy Flow in Organisms

Plants need water and light to live and grow. (K-LS1-1)

ESS3.C: Human Impacts on Earth Systems

Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (K-ESS3-3)

ETS1.B: Developing Possible Solutions

Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-ESS3-3)

LS1.A: Structure and Function

All organisms have external parts. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)

LS1.D: Information Processing

Plants also respond to some external inputs.(1-LS1-1)

PS1.A: Structure and Properties of Matter

Crosscutting Concepts:

Patterns

Patterns in the natural and human designed world can be observed and used as evidence. (K-LS1-1)

Cause and Effect

Events have causes that generate observable patterns. (K-ESS3-3), (2-LS2-1)

Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2)

Structure and Function

The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1), (K-2-ETS1-2)

Influence of Science, Engineering and Technology on Society and the Natural World

Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (1-LS1-1), (2-PS1-2)

Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. (2-LS2-1) Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1) **Asking Questions and Defining Problems** Asking questions and defining problems in K– 2 builds on prior experiences and progresses to simple descriptive questions. (K-2-ETS1-1) Ask questions based on observations to find more information about the natural and/or designed world(s).(K-2-ETS1-1) Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) **Developing and Using Models** Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. (K-2-ETS1-2) Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)	Different properties are suited to different purposes. (2-PS1-2) **LS2.A: Interdependent Relationships in Ecosystems** Plants depend on water and light to grow. (2-LS2-1) **ETS1.A: Defining and Delimiting Engineering Problems** A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1) **ETS1.B: Developing Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2) **ETS1.C: Optimizing the Design Solution** Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	

Possible Preconceptions/Misconceptions:

- Plants need dirt in order to grow.
- Plants only need the sun in order to grow.
- Plants require water and fertilizer.
- Plants must grow outside.
- Plants use the oxygen that is in the air.

LESSON PLAN: 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

A dialogue can be opened in which teachers lead students in a discussion of what types of things settlers would need if they were forced to live in extreme conditions (the desert, the arctic, a space station, or even Mars). It should be highlighted that plants are the beginning of the food chain and will be needed no matter where we go.

You can show them some of the prepackaged, dehydrated food that astronauts eat when they are in space. Ask them

why they may prefer to have other options. You can also discuss the other benefits of having plants (air purification, water purification, mental wellness).

Students should also observe different types of dirt and soil (sand, gravel, topsoil) and decide what makes them different and which they think would be best for growing plants and why. Students should also observe different types of hydroponic growing media (perlite, coconut coir, hydroton, rockwool) and ask them what the major differences are.

EXPLORE: Lesson Description -

The lesson will begin with a teacher led narrative to discuss the needs of plants from their environment and how they acquire each resource. Students should then be broken into small groups to discuss what challenges they feel space travelers would encounter while trying to provide these resources to their crops. You may also wish to discuss these same challenges in certain environments here on Earth (deserts, arctic, congested cities, etc).

After thoughts are exchanged in a whole group setting, one should come to the conclusion that plants will needs to be grown indoors and with very scarce resources. It should also be noted that all materials become important in these types of growing conditions and what we may have traditionally considered to be “rubbish” is in fact a useful tool.

Students will be given materials and asked to construct a small planter that is capable of providing water and nutrients to their seedlings (see materials needed below). Follow the tutorial provided with this lesson to construct your wick systems. Students should select one of the hydroponic growing materials they feel will do the best job to fill their planters.

Students will use the provided worksheets to evaluate their design and make predictions about what they expect to happen. They should account for how the plants will be acquiring the needed resources from the growing environments you set up.

Over the weeks that follow, students will use the attached data sheets to monitor the differences in their hydroponic planters and their plants growing in soil. Students will be asked to draw conclusions about the pros and cons of hydroponic farming.

Materials Needed:

- Empty 2L plastic bottles (or size of your choosing)
- ¼ inch braided nylon rope
- Aluminum foil
- Scotch tape
- Pots/containers for plants grown in soil
- Potting soil
- Various hydroponic growing media (perlite, coconut coir, hydroton, rockwool)
- Seedlings (or seeds is starting on your own)
- Hydroponic nutrients (see bill of sale)
- pH adjustment solutions (see bill of sale)

Probing or Clarifying Questions:

1. What makes topsoil different from sand and gravel? Where does this material come from?
2. Why do environments like deserts, the arctic, or space lack these materials in their dirt?
3. What resources would be difficult to come by when growing plants in space?
4. What challenges would astronauts face while trying to grow a crop in space?
5. What benefits besides being a food source would plants provide?

EXPLAIN: Concepts Explained and Vocabulary Defined

Teacher:

- Asks for justifications (evidence) and clarification from students to provide evidence for answers given to the discussion questions.
- Formally provides definitions, explanations, and new labels
- Vocabulary: Photosynthesis, producer, consumer, growing medium, upcycling,

Students:

- Uses their recorded observations in explanations.
- Listens critically to others' explanations.
- Compares data taken from competing designs to form conclusions

ELABORATE: Applications and Extensions

Teacher:

- Refers students to existing data and evidence and asks: What do you already know? Why do you think…?

Students:

- On a blank sheet of paper, encourage students to draw and label their wick system creation while in use.
- Regroup students with new partners and have students check for understanding with their peers.
- Students will communicate with peer groups in different countries to compare the crops they selected and the success in their design.

EVALUATE: Formative Monitoring (Questioning / Discussion):

Teacher:

- Asks open ended questions such as: Why do you think….? How would you explain…? What evidence do you have?
- Introduces the engineering process of iterative design by asking: What mistakes may you have made?....What changes would you make to your next attempt?

Students:

- Answers open ended questions by using observations, evidence, and previously accepted explanations.
- Asks related questions that would encourage future investigations.

Summative Assessment (Quiz / Project / Report): End of Unit group quiz and virtual discussion with international partner classes.

Reflection:

Ask students to observe these concepts in real world applications and explain them using support from their recorded observations.

Common Core State Standards Connections:

ELA/Literacy -

W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. (K-ESS3-3)

W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-LS1-1)

W.1.7 Participate in shared research and writing projects (e.g., explore a number of “how-to” books on a given topic and use them to write a sequence of instructions). (1-LS1-1)

RI.2.1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (K-2-ETS1-1)

W.2.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. (K-2-ETS1-1), (K-2-ETS1-3)

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1)

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1), (K-2-ETS1-1), (K-2-ETS1-3)

SL.2.5 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (K-2-ETS1-2)

Mathematics -

K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has “more of”/”less of” the attribute, and describe the difference. (K-LS1-1)

MP.2 Reason abstractly and quantitatively. (2-LS2-1), (K-2-ETS1-1), (K-2-ETS1-3)

MP.4 Model with mathematics. (2-LS2-1), (K-2-ETS1-1), (K-2-ETS1-3)

MP.5 Use appropriate tools strategically. (2-LS2-1), (K-2-ETS1-1), (K-2-ETS1-3)

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1), (K-2-ETS1-3)

Notes for Future Reference: