Endeavor STEM Teaching Certificate Project
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6/29/2020

Arts Integrated STEM Lesson Plan

Lesson Title: How Do Plants and Animals Rely on One Another: An Introduction to Hydroponics and Aquaponics

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Topic: Scientists, Engineers, and Artists must be able to observe and identify key factors that interact with one another in the natural world. The ability to identify the similarities between the way plants and animals interact with one another as well as rely on one another to survive in a specific ecosystem enables students to comprehend how elements in nature are connected. This, in turn, allows students to better understand how to care for the surrounding environment and how ecosystems rely on all factors to thrive. The students will conduct a hydroponic experiment, where they will build and observe three tanks with vegetation on the lid, one with soil, one with just water, and one with aquatic creatures in water located in the lower section of the tank. The students will record their observations and determine which tank's vegetation is thriving more. The art component of this lesson will be within the student's observational recordings and a final presentation which will showcase the student's illustrations after a month of observations. Students will also be using 3-dimensional design and animation to test their engineering design before building.

Targeted Grade Level: Grade 2

Time Needed: 30 – 40 minutes per day for initial lesson, 5 days for overall lesson. 1 month of ongoing observations, each observation and recording will last about 10 minutes over the course of one month.

Subject Integration: Art, Science, and Engineering

Justification: Art, science, and engineering are integrated in this lesson in several ways. Students will use art to record their observations through illustration, multimedia, or digital art making. They will also use 3-dimensional design or animation as a proposal for their engineering design. Science will be used to explain why the specific ecosystem is living better than the other, by students using the scientific method throughout their experimentation. Engineering will come into play by the students building and designing their tanks. This integration is logical because it comes naturally when conducting this form of experimentation. It will enhance student learning because this specific integration of subject matter addresses differentiated instruction techniques and addresses the Howard Garner learning styles as well as project and inquiry-based learning.

Standards:

2-LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

• 2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]

• 2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
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,	**LS2.A: Interdependent Relationships in Ecosystems** • Plants depend on water and light to grow. (2-LS2-1) • Plants depend on animals	**Cause and Effect** • Events have causes that generate observable patterns. (2-LS2-1)

diorama, dramatization, or storyboard) that represent concrete events or design solutions. • Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) **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. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)	for pollination or to move their seeds around. (2-LS2-2) **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. (secondary to 2-LS2-2)	**Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)
Common Core State Standards: **Math:** • MP.2 Reason abstractly and quantitatively. (2-LS2-1)		

• MP.4 Model with mathematics. (2-LS2-1), (2-LS2-2)

• MP.5 Use appropriate tools strategically. (2-LS2-1)

• 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. (2-LS2-2)

ELA:

• 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)

• 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. (2-LS2-2)

ITEEA Standards

STEL- 1A: Compare the natural world and the human-made world.

STEL-1B: Explain the tools and techniques that people use to help them do things.

National Art Standards

- Perceive and describe aesthetic characteristics of one's natural world and constructed environments.
- Develop a work of art based on observations of surroundings.
- Interpret art by analyzing use of media to create subject matter, characteristics of form, and mood.
- Investigate and discuss possibilities and limitations of spaces, including electronic, for exhibiting artwork.

Measurable Student Learning Objectives:

Students will be able to plan, design, and conduct an investigation through experimentation and analyze through observations to determine what plants need to live. By recording the factors of sunlight, soil, water and other environmental conditions, the students will be able to show what their plants need to live and their research that supports it. Students will also be able to develop a simple model that mimics the function of an animal pollinating plants by creating three hydroponic tanks, one with aquatic life and two without, and making comparisons though observations and recordings. In this way, students will also be able to perceive and describe aesthetic characteristics of one's natural world and constructed environments and develop a work of art based on observations of surroundings.

Nature of STEM: This lesson addresses the nature of STEM by integrating several subjects relating to art and STEM – science, art, and engineering –the students will be thinking like artists through illustrative notetaking and observational recordings, as well as through 3-dimensional art or animation creation. Students will be thinking like scientists by hypothesizing outcomes and conducting experiments to test. Students will be thinking like engineers by designing and constructing a functioning tank that can harbor varieties of aquatic life and plant life.

Engaging Context/Phenomena: Begin the lesson by comparing the size, shape, and color of three pictured plants – one grown hydroponically without aquatic life, one with aquatic life (aquaponics), and one grown normally with soil in a pot. Then utilizing the following articles,

https://www.nasa.gov/offices/oct/home/tech_life_asa_analytics.html

https://www.nasa.gov/missions/science/biofarming.html

https://www.nasa.gov/audience/foreducators/9-12/features/aquaponics.html

to introduce the reasoning behind the use of hydroponics in long-term space travel. Astronauts' main solutions for future deep space travel include the use of hydroponics, which supplies consistent outlets for food, clean air and water, and a way to deal with the disposal of waste.

Data Integration: Students will be collecting and analyzing data through observations of plant growth. I will also use the NASA provided data by showing the following informational video:

https://www.youtube.com/watch?v=gdmQxfdJ4b0&feature=youtu.be

Students will be using this data to prove whether soil, hydroponics, or aquaponics is a better source for growing plants, if it is more efficient, if there are more nutrients provided with hydroponics, aquaponics, or soil, and how aquatic creatures affect the growth of the plant compared to just using water or soil.

Furthermore, I will use the resource:

https://www.nasa.gov/mission_pages/station/research/news/tomatosphere/

https://www.firsttheseedfoundation.org/tomatosphere/

as a another provided material for students to explore during their inquiry-based research.

Differentiation of Instruction: This lesson is very interactive, allowing students who understand concepts in a kinesthetic way to dive into the experiment. This lesson will also feature auditory and visual features allowing those who learn by hearing or seeing to grasp the concepts accordingly as well. The deeper and thought-provoking information can be accessed in a way that is still comprehensible when explained for a classroom filled with diverse learners. Certain needs can be addressed by presenting information by using a variety of vocabulary terms.

Real-life Connection: The real-life connections to this lesson are that students can design and create their own hydroponic systems in order to grow edible plants. Also, those who love science, art, and thinking outside of the box can explore agricultural practices in a new way through hydroponics. Culturally responsive teaching practices can be used by relating hydroponics to visiting the grocery store or pet store and combining these visits to create hydroponics. This relates to the students' everyday lives because these are places that students normally go to with their parents, siblings, or friends. Finally, the connection of potential career options will be introduced – hydroponics and aquaponics can relate to interior design, 3-dimensional design, and animation, as well as agriculture, architecture, and aerospace career fields.

Possible Misconceptions: Some common misconceptions may occur when building the hydroponic tank or listening to the NASA hydroponics data. This lesson will be delivered with a simple execution - utilizing visuals, auditory, and kinesthetic resources to give students the opportunity to comprehend what they need to know and how to put their knowledge and skills together to create a functioning model of an ecosystem.

Lesson Procedure:

5E Model	5E Objectives
Engage	**Procedure:**

Introduce the lesson with an anchoring phenomenon. Facilitate student questions, discussion, etc. as appropriate. Learn about what students already know and want to know.	The teacher introduces the lesson by first asking the students what they know about plants and what they know about fish and aquariums. After reviewing the students' prior knowledge, the teacher will then show three photographs side-by-side on the smartboard – one of a picture of a plant in soil and a pot, the other two pictures of a hydroponically grown plant, one with fish and one without. The teacher then will facilitate a discussion by asking the questions – what do you notice about each of these plants? What is similar? What is different? In this engagement, students may bounce ideas off one another.  After the discussion, the teacher will ask the students to take out their science journals. This specific journal has an open space for illustration and lines underneath for writing. The teacher will ask the students to draw the three examples they see on the board, then make a prediction of which plant will grow the tallest and largest and why. Extension: (If time permits) Before the end of this portion of the lesson, the students will be introduced to Tomatosphere through the NASA provided article and video. The students will be using the tomato saplings for their tank experiments. However, the students may plant tomato seeds in a separate pot with soil. In this way, the students will be able to monitor the progress of seeds that flew in the international space station

	and see how they grow compared to seeds that were produced on Earth. **Modifications:** The students can also receive printed pictures of the examples on the board to hold and view more closely. **Standards Addressed:** • 2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and water to grow. • W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1) **Formative/Summative Assessments:** In this phase, students will be assessed based on their answers during the discussion as well as their predictions. **Resources:** https://www.hydroponics.net/learn/hydroponic_gardening_for_beginners.php https://settlement.arc.nasa.gov/teacher/lessons/contributed/thomas/hydroponics/hydroponics.html https://morningchores.com/aquaponics/ https://www.nasa.gov/mission_pages/station/research/news/tomatosphere/ https://www.firsttheseedfoundation.org/tomatosphere/ https://youtu.be/HU5kpIQ09Iw

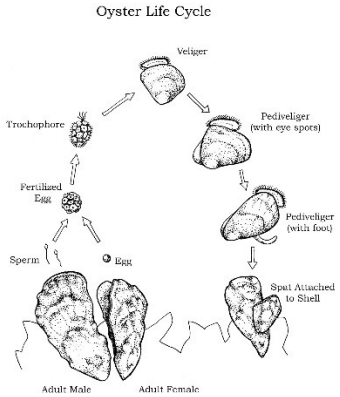
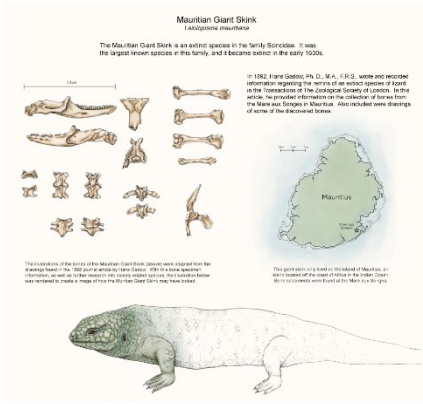
Explore *Plan for students to engage in hands-on activities that are designed to facilitate conceptual change.*	**Procedure:** The teacher will begin this phase by showing the NASA provided data through the informational video (link below). Then the teacher will ask the students to use their school provided iPads to read the three provided NASA articles (links below). When students finish reading both articles, the teacher will ask them to write down three things they found interesting from the two articles in their science journals. The students will then watch the youtube video on aquaponics (link below). Then the teacher will create 3 groups of students. Each group will be assigned to create 3 specific tanks for growing plants. On 3 sheets of paper, one of the three following tasks is written – create a tank that grows a plant in soil, create a tank that grows a plant in water, create a tank that grows a plant and can hold fish. Each group will receive all three tasks. The teacher will then ask the students to use their science journals to illustrate their designs for their specific plant systems. During this phase, the students will be able to use their iPads to research different ways to create 3 functioning tanks, one with fish, one with soil, and one with water. Each group of students will be given three plastic tanks (3 gallons), three tomato saplings and soil, water, and water and a fish. The rest of the design is up to them. After the students complete their designs, they will upload their illustration to google classroom, where their group can access each person's illustration and work together to create a final design. The teacher will also assign the resources listed as a facilitated and guided method to direct students while researching. **Modifications:** The students can use the google classroom as a resource to talk with their partners online and provide any additional research in order to have a say in the project. **Standards Addressed:** • 2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight

	and water to grow. • MP.2 Reason abstractly and quantitatively. (2-LS2-1) • MP.5 Use appropriate tools strategically. (2-LS2-1) • Perceive and describe aesthetic characteristics of one's natural world and constructed environments. • Develop a work of art based on observations of surroundings. • 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) **Formative/Summative Assessments:** In this phase of the lesson, the students will be assessed based on their engagement in research, their illustration of their engineering design, and their participation on the google classroom platform. **Resources:** https://www.youtube.com/watch?v=gdmQxfdJ4b0&feature=youtu.be https://youtu.be/JAN6Tz4IwmA https://www.nasa.gov/audience/foreducators/9-12/features/aquaponics.html https://www.nasa.gov/offices/oct/home/tech_life_asa_analytics.html https://www.nasa.gov/missions/science/biofarming.html
	Procedure: After completing their collaborative designs, each group of students will create a

Explain *Facilitate opportunities for students to explain their understanding of concepts and processes and make sense of new concepts.*	proposal for their engineering process and present it to the teacher. The students will be required to use their research to back up their claims as to why their engineering designs should be built the way they plan. The students will be required to use 3-dimensional design or animation when creating their proposals – these skills will be taught prior to the lessons. If the students need any materials that are not accessible initially, they will tell the teacher and the teacher will supply it the following day when building. **Modifications:** During this phase, the students will be able to visit the library to check out any books regarding agriculture, planting, or hydroponics to use as research to back their design. This way students that prefer reading books rather than digitally can still access valuable information. More so, the students who are not comfortable with presenting can write their proposal and submit it to the teacher for review. **Standards Addressed:** • 2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. • 2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and water to grow. • MP.2 Reason abstractly and quantitatively. (2-LS2-1) • MP.5 Use appropriate tools strategically. (2-LS2-1) • Perceive and describe aesthetic characteristics of one's natural world and constructed environments. • Develop a work of art based on observations of surroundings. • 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)

	Formative/Summative Assessments: The students will be assessed based on their design, proposals, and research during this phase of the lesson. **Resources:** https://www.epicgardening.com/hydroponics-for-beginners/ https://www.aquaponicsdiyer.com/how-to-build-an-aquaponics-system/ https://www.nasa.gov/offices/oct/home/tech_life_asa_analytics.html https://www.nasa.gov/missions/science/biofarming.html https://www.advancednutrients.com/articles/aeroponics-and-nasa/ https://settlement.arc.nasa.gov/teacher/lessons/contributed/thomas/hydroponics/hydrobuild.html
Elaborate *Provide applications of concepts and opportunities to challenge and deep ideas; build on or extend understanding and skills.*	**Procedure:** During this phase of the lesson, the students will be able to put their research and design plans into action. After discussing their plans and reasoning with the teacher, the students will begin to place their materials together to create a sustainable living situation for their plants and fish. In this phase, the students will continue to build and test their designs until it is suitable for evaluation. The students will be provided with four articles (links below) to help them determine which engineering designs are suitable for each tank and plant. **Modifications:** Each student can receive a specific job when building if the work is not rationed equally, including illustrator, recorder, builder, ect.

	Standards Addressed: • 2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and water to grow. • 2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. • MP.2 Reason abstractly and quantitatively. (2-LS2-1) • MP.5 Use appropriate tools strategically. (2-LS2-1) • Perceive and describe aesthetic characteristics of one's natural world and constructed environments. • Develop a work of art based on observations of surroundings. • 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) **Formative/Summative Assessments:** The students will be assessed through their effort of design and testing. **Resources:** https://www.modandmint.com/how-to-houseplant-water-propagation/ https://www.aquaponicsdiyer.com/how-to-build-an-aquaponics-system/ https://www.epicgardening.com/hydroponics-for-beginners/ https://aquaponicsexposed.com/aquaponics-for-kids/
Evaluate	**Procedure:** Before beginning this phase, the teacher will use the article, *Scientific Illustration: What is it?* to explain how and why the students will be using scientific illustrations to

Assess students knowledge, skills and abilities.	evaluate the plant growth in each tank. The teacher will display the article on the smartboard and read aloud, allowing students to read along and view the provided visual examples:    The teacher will then introduce the article *Making a Scientific Illustration* and present it on the smartboard in the same way as before. In this way, the teacher will be introducing the methods and techniques of creating scientific illustrations. In this phase, the students in each group will begin to conduct their continued observations and recordings by illustrating the growth of the three plants. The plants will be placed on the windowsill to have a continuous source of sunlight supplied. The potted plant with soil will receive 1 cup of water every other day. The students will record their observations in their science journals twice a week for one month by using the scientific illustration technique. Each observation will last about ten minutes. At the end of the month, the students will compile their illustrations into a small portfolio, they will then create a final scientific illustration of the growth cycle of each plant in each tank through a digital artmaking platform. When complete, the students

	will present their observations in a teacher facilitated group discussion. During this time, the students will answer questions such as – why do you think one plant grew larger or faster than the other? Did your prediction prove to be true? **Modifications:** The students that do not feel comfortable speaking during the discussion can pass a note to the teacher, and the teacher can read their observations aloud to the class. **Standards Addressed:** • 2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and water to grow. • 2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. • Perceive and describe aesthetic characteristics of one's natural world and constructed environments. • Develop a work of art based on observations of surroundings. • 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) **Formative/Summative Assessments:** The students will be assessed based on their observational recording and final portfolio. **Resources:** https://www.fi.edu/blog/scientific-illustration-what-is-it https://www.fi.edu/blog/making-a-scientific-illustration

Teacher Background: The teacher needs to have specific background information that pertains to hydroponics, animation, 3-dimensional design, and observational scientific illustration.

Hydroponics:

https://www.epicgardening.com/hydroponics-for-beginners/

https://www.nasa.gov/offices/oct/home/tech_life_asa_analytics.html

https://www.nasa.gov/missions/science/biofarming.html

https://www.advancednutrients.com/articles/aeroponics-and-nasa/

https://www.modandmint.com/how-to-houseplant-water-propagation/

https://www.youtube.com/watch?v=gdmQxfdJ4b0&feature=youtu.be

https://settlement.arc.nasa.gov/teacher/lessons/contributed/thomas/hydroponics/hydrobuild.html

https://www.hydroponics.net/learn/hydroponic_gardening_for_beginners.php

Aquaponics:

https://youtu.be/JAN6Tz4IwmA

https://morningchores.com/aquaponics/

https://www.aquaponicsdiyer.com/how-to-build-an-aquaponics-system/

https://aquaponicsexposed.com/aquaponics-for-kids/

Scientific Illustration:

https://www.fi.edu/blog/scientific-illustration-what-is-it

https://www.fi.edu/blog/making-a-scientific-illustration

3-dimensional Design and Animation:

https://theartofeducation.edu/2017/12/13/using-morphi-transform-3d-design-classroom/

https://theartofeducation.edu/packs/digital-animation/

https://www.teachthought.com/technology/50-animation-tools-resources-digital-learners/

https://video.search.yahoo.com/search/video?fr=mcafee&p=animation+for+teachers+to+teach#id=2&vid=83ebe53d9d1af7ebc8e6e4fe91503d8b&action=click