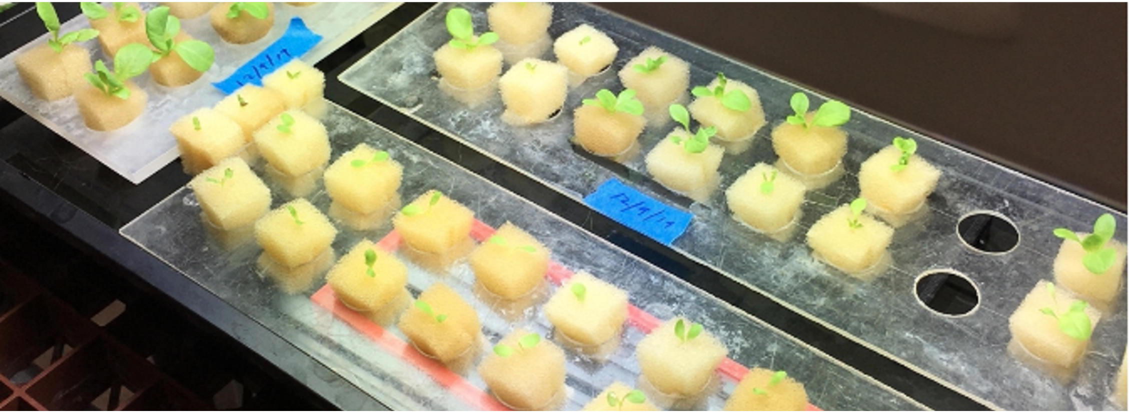
Ilima Intermediate



Hydroponics Project SY21-22
Research, System Design and Community Impact

Pacing and Outline Quarter 1 : Randall Shinn

for STEAM Entrepreneurship and Research Network– GEER Grant

v.2021

Schedule for Quarter 1

Target Date	Project Phase	Target Activity
Week 1 Aug 30-Sept 3	Phase 1: Background Information	• Introduction to Hydroponics • Compare and contrast traditional farming and hydroponics
Week 2 Sept 7-10	Phase 2: Background Information	• Introduction to Kratky Hydroponic System
Week 3 Sept 13-17	Phase 3: Seed Germination - (will take 2 weeks to get seedlings stage) - Ongoing plant observations, nutrient check and re-fill if necessary (document in notebook) - Grow period & data collection (take about 1 month for growth cycle) - Data Collection - Weight lettuce, Evaluation: System Design	
Week 4 Sept 20-24	Phase 4: Hydroponic Project	• Need to Know (Student Driven)
Week 5-7 Sept 27-Oct 1 Oct 4-8	Phase 5: Meet the Expert	• Meet with Expert

Content Knowledge

Background Information

<u>Learning Intention (</u>This is *what* I want you to learn and this is *why* it is important)**<u>:</u>**

- ❑ I will describe what plants need in order for it to grow.

<u>Success Criteria</u> (This is *how* you will show me that you mastered the material)

- ❑ Identify the things that plants need in order to grow.
- ❑ Describe how photosynthesis provides food/energy for plants.

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Phase 1: PLANT BASICS REVIEW

Plant Review

- What do plants need to grow? Which plant features perform which functions?

- Is it possible for a plant to grow without sunlight?

- Is it possible for a plant to grow without soil?

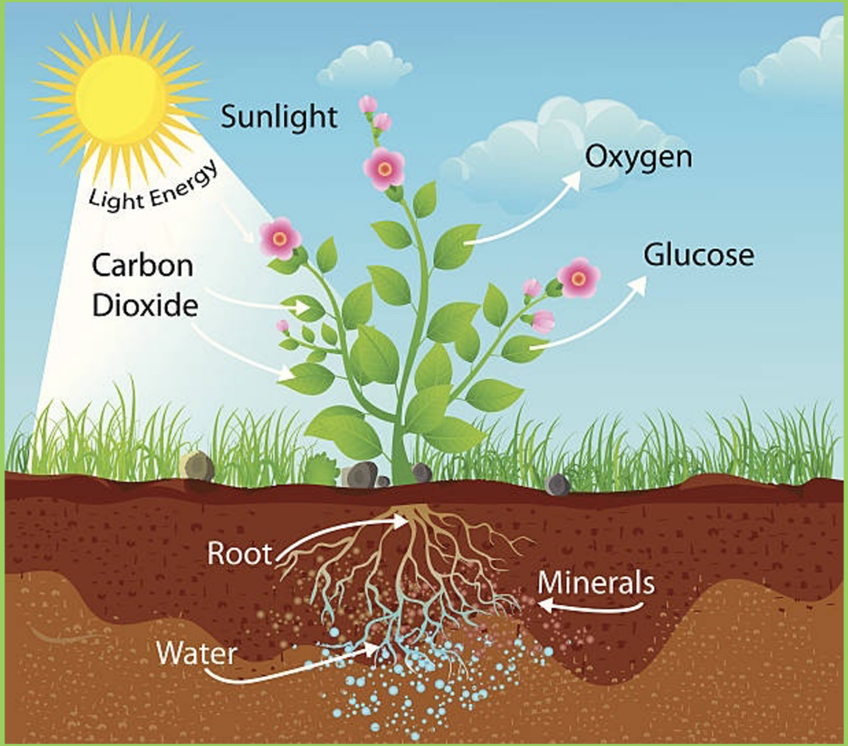
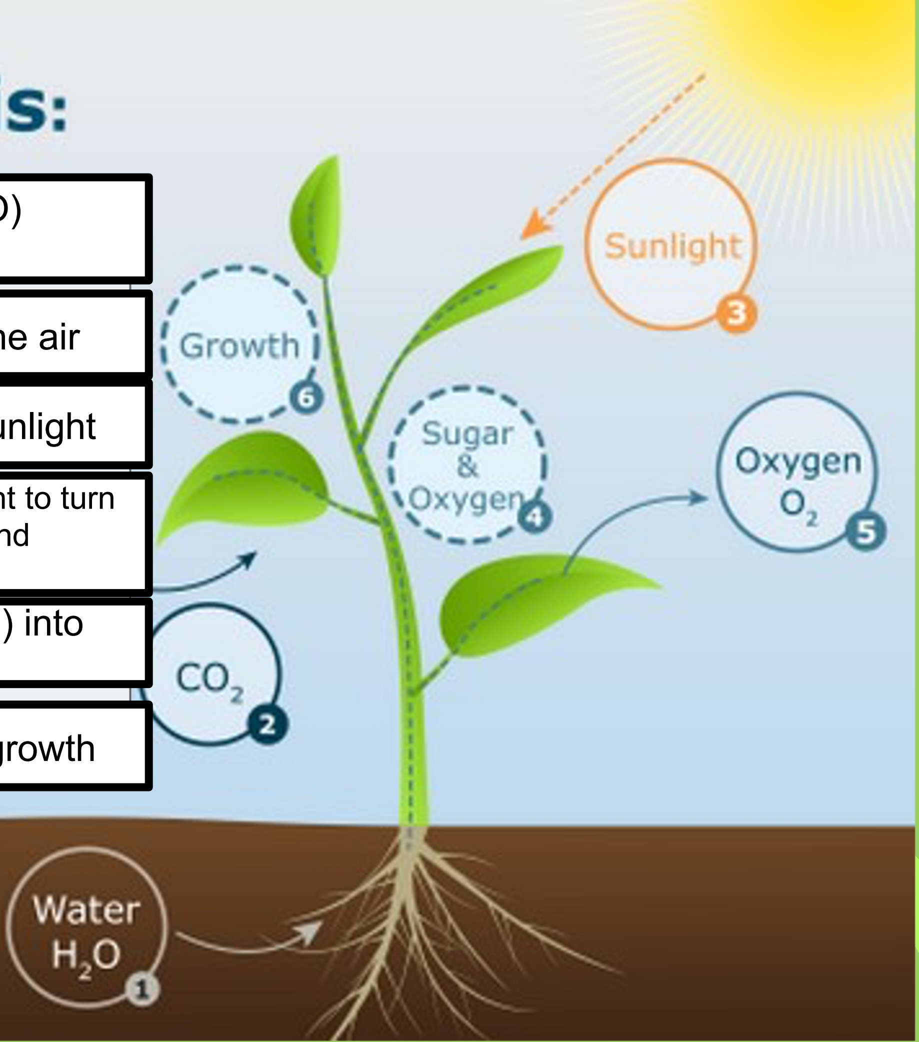


Photo: iStock

Photosynthesis:

1. The plant draws up water (H_2O) through its roots
2. The leaves take in CO_2 from the air
3. The leaves trap energy from sunlight
4. The plant uses the energy of sunlight to turn water (H_2O) and CO_2 into sugars and oxygen (O_2)
5. The plant releases oxygen (O_2) into the air
6. The plant uses the sugars for growth



WAGENINGEN UNIVERSITY & RESEARCH

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- ✓ Describe how photosynthesis provides food/energy for plants.

Phase 2: What is HYDROPONICS?

Background Information (Mr. Shinn)

Learning Intention (This is *what* I want you to learn and this is *why* it is important):

- ❑ I will describe what hydroponics is, the benefits and challenges that it is associated with it.

Success Criteria (This is *how* you will show me that you mastered the material)

- ❑ **Read and discuss with a partner** the basics of hydroponics
- ❑ **Compare and contrast** traditional farming vs hydroponics using a double bubble thinking map.
- ❑ **Orally discuss as a class** how hydroponics is used in the real world.
- ❑ **Reflect and discuss as a class** on the benefits and challenges of hydroponics.
- ❑ **Write a reflection summary (4-5 sentences) on the Kratky Method** including the following terms: Hydroponics, Non-circulating, Nutrient solution, Capillary action, Germinate, Roots, Net pot

Hydroponics Basics

- Hydroponics is the method of growing plants without soil. Nutrients are provided through a water solution designed specifically for the plants' needs.
- Light energy is typically provided via natural sunlight, or with artificial grow lights when grown indoors.

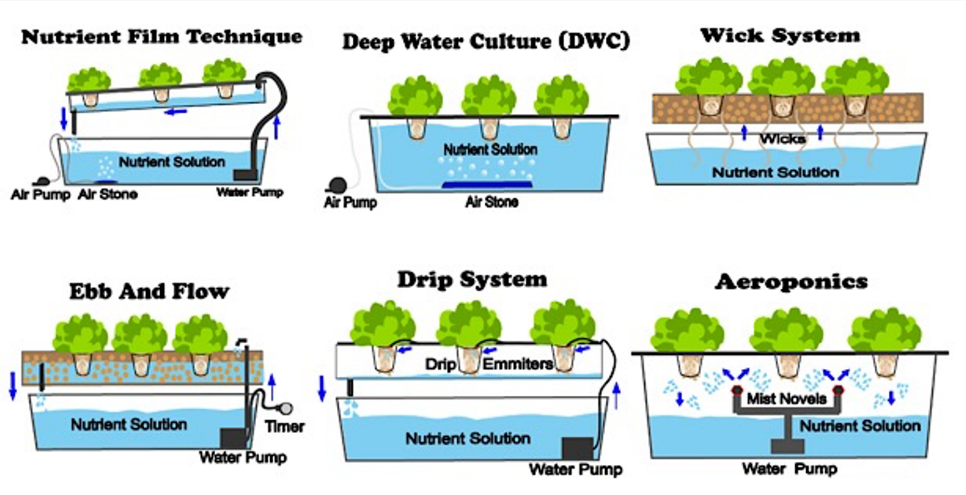

Photo: ColorGardening

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Traditional Farming	Hydroponics
	
Traditional farming involves growing plants in regular or amended soils. Plants are grown in raised beds, pots/containers, or most traditionally, in the ground.	Hydroponics is a plant growing system that uses water and fertilizer aqueous solutions to provide the nutrients plants need. This method grows plants without soil.
<u>Pros:</u> + Low cost + Easiest growing method for all levels	<u>Pros:</u> + Keeps the plants from insects and animals + Easy to set up indoors and outdoors + Good for small spaces + Clean
<u>Cons:</u> - Needs a lot of space to grow - Water cannot not recycled or reused - Plants susceptible to soil born diseases - Susceptible to insect and animal damage - Needs to be watered often	<u>Cons:</u> - Expensive - Water has to be changed every so often - Root rotting

Diagram: STEM Pre-Academy

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Hydroponics in the Real World

In **SPACE** : Greenhouse inside the International Space Station

In the **DESERT** : Greenhouse in the Egyptian desert.

At **DISNEY WORLD**: Rated as one of the best displays of sustainable agriculture.

In **Urban Settings**: Mass food productions. Enough to feed the city. https://foodandcity.org/urban-agriculture-can-feed-cities/

Images source: Google.com

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Reflect & Discuss

- What are some benefits of hydroponics?
- What are some challenges associated with hydroponics?
- Who do you think would most benefit from these kinds of systems?

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THE KRATKY METHOD

“Non-circulating Hydroponics Method”

Basic Vocabulary

- Hydroponics
- Non-circulating
- Nutrient solution
- Capillary action
- Germinate
- Roots
- Net pot

Background

- This method was developed by Dr. Bernie Kratky, a <u>**horticulturist**</u> from the College of Tropical Agriculture and Human Resources at University of Hawaii, Hilo.

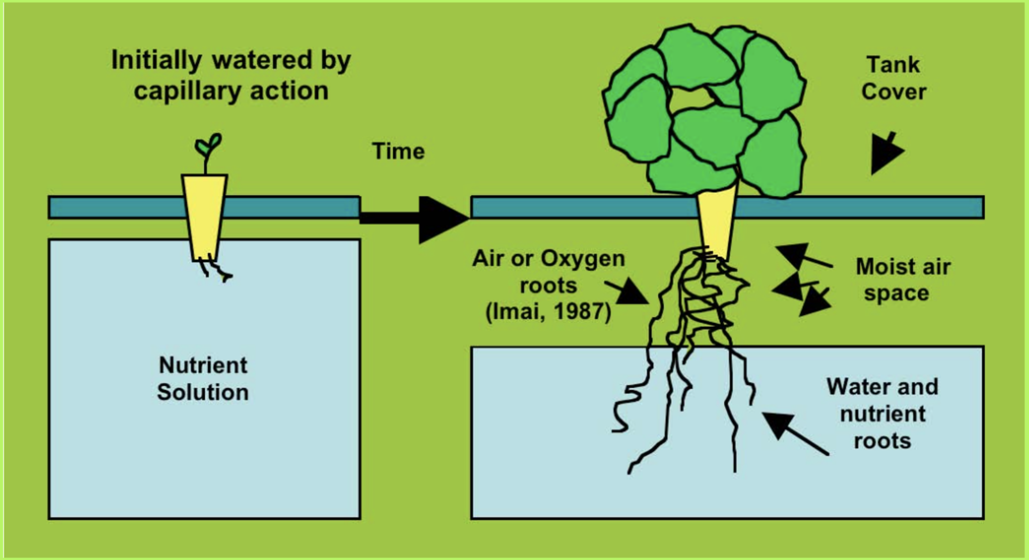
- **Dr. Kratky's method is founded on principles of:**
  - ***Low-maintenance***
  - ***efficiency***
  - ***sustainability***

Photo: University of Hawaii

The Kratky Method

- **Non-circulating hydroponics method** designed for a germination-to-harvest cycle with only a **single** dosage of nutrients.

- **Suspended plants** grow roots toward the nutrient solution, absorbing water and nutrients essential for plant growth.

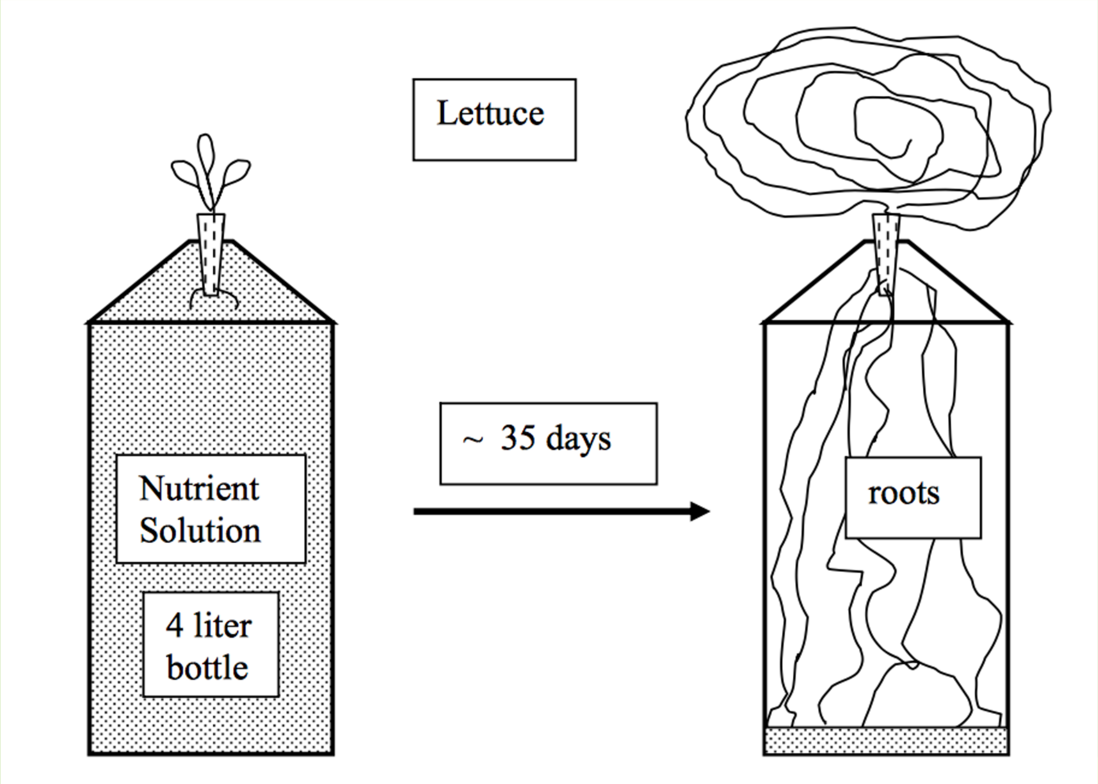


Kratky, 2010.

Things to Remember

- The roots should always touch the water

- Keep the net pot in the container



Kratky, 2004.

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Phase 3: GERMINATION

Background Information (Mr. Shinn)

Learning Intention (This is *what* I want you to learn and this is *why* it is important):

- ❑ I will germinate plant seedlings in a soilless environment and learn about the parameters necessary for plant growth-sustainability.

Success Criteria (This is *how* you will show me that you mastered the material)

- ❑ **Discuss with partners** a customer's request for seedlings and manoa lettuce.
- ❑ **Read the steps** on how to germinate seedlings and **orally summarize** the steps with your partners.
- ❑ **Orally discuss** the pro's and con's for germinating seedlings using sentence stems "**The pros are …. The cons are…**"
- ❑ **Germinate** the customer's request for seedlings and fully grown manoa lettuce.

Photo: STEM Pre-Academy

Ilima INTERMEDIATE Pūpūkahi I Holomua

Photo: STEM Pre-Academy

Your Customer

Ilima Intermediate School has placed an order for seedlings.

- 40 lettuce seedlings
- 40 bok choy seedlings

Seedling should be hardened and ready for outdoor planting in greenhouse.

Background Information (Mr. Shinn)

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- ❑ **Germinate** the customer's request for seedlings and fully grown manoa lettuce.

Materials and Supplies

#	Material
1	Seeds (Anuenue Lettuce)
2	1.5” Rockwool (98 cubes sheets)
3	2” Net Cups (100 {Pack)
4	Fertilizer (masterblend complete kit)
5	Plastic Germination Tray and Hood
6	Filtered Water (for germination and nutrient solution)
7	Grow light
8	Scale (to weigh final lettuce)
9	Measuring cups

GERMINATION

Germination

STEP 1:

Soak the rockwool cubes with the **filtered** water.

Photo: STEM Pre-Academy

Germination (cont.)

STEP 2:

Drain the excess water.

DO NOT squeeze the cubes.

Photo: STEM Pre-Academy

Germination (cont.)

STEP 3:

Place all your drained cubes on a tray or plate labelled with your name and the seed name.

Photo: STEM Pre-Academy

Germination (cont.)

STEP 4:

Use the wood tool to **GENTLY** open the hole on top of your cubes (about 1-1/2 centimeter deep).

Photo: STEM Pre-Academy

Germination (cont.)

STEP 5:

Carefully place 2 seeds onto the tip of the wood tool.

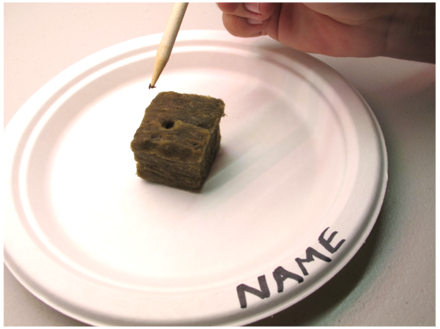
Tip: Wetting the tip helps grab the seed easier.

Photo: STEM Pre-Academy

Germination (cont.)

STEP 6:

Use the wood tool to gently place the seeds into the hole.



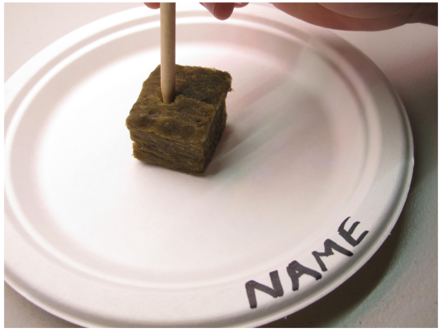


Photo: STEM Pre-Academy

Germination (cont.)

STEP 7:

GENTLY pinch the hole shut.

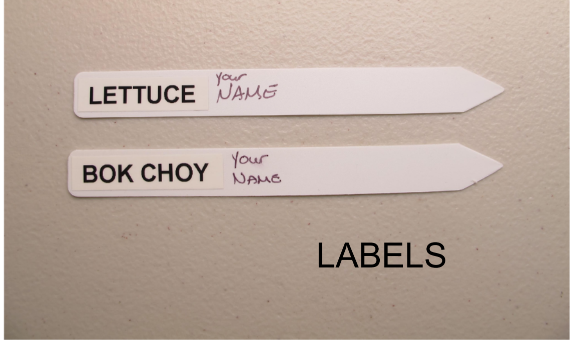
Photo: STEM Pre-Academy

Germination (cont.)

STEP 8:

Place your cubes into the grow tray, along with your classmates'.

Label your cubes with your name and seed name.



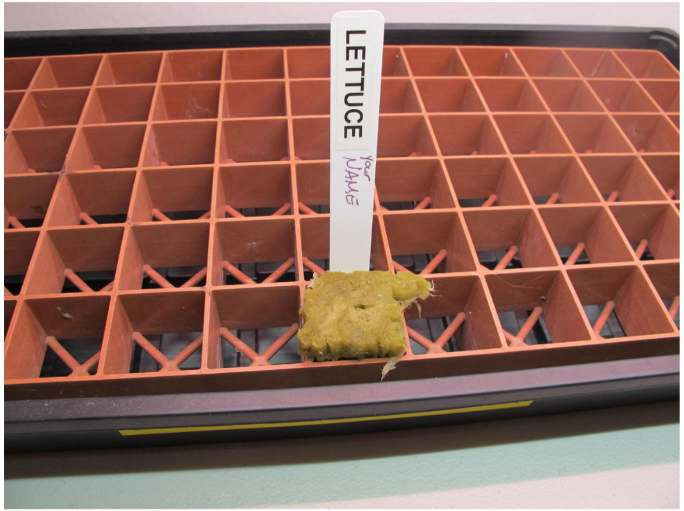


Photo: STEM Pre-Academy

Germination (cont.)

STEP 9:

Place the tray underneath the grow light. Cover the tray with the plastic dome, keeping vents closed until seeds begin to sprout (a couple of days).

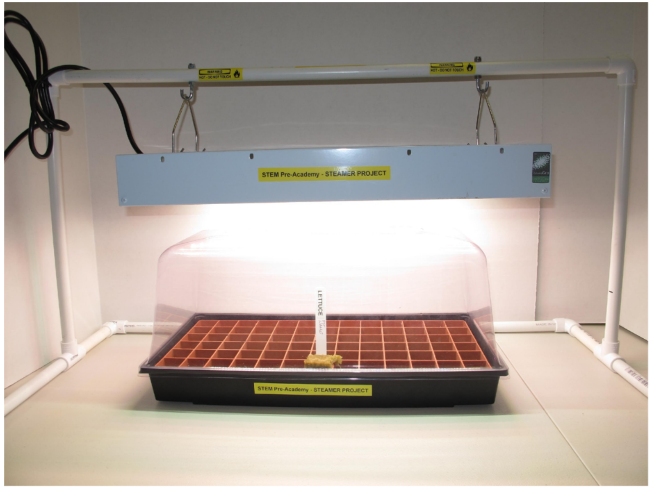


Photo: STEM Pre-Academy

Germination (cont.)

STEP 10:

Once the seeds sprout, keep vents slightly open or lift the dome daily to refresh the interna air.

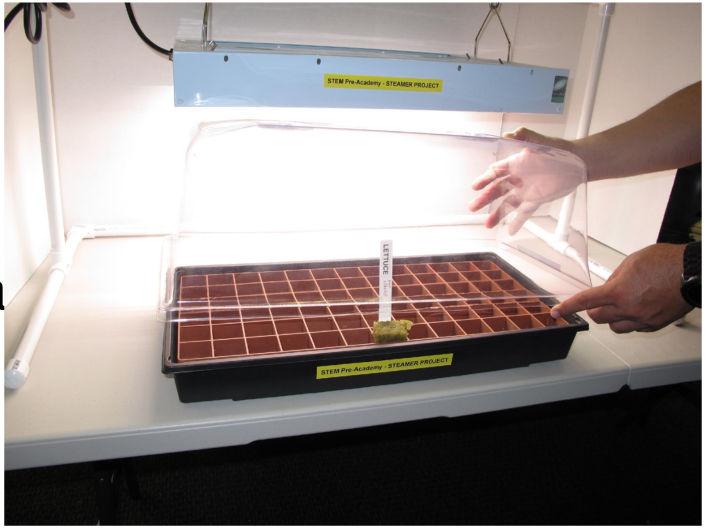


Photo: STEM Pre-Academy

Germination (cont.)

STEP 11:

Once the roots have grown at least 1 inch outside the cube, your seedling is ready for transplantation!

Photo: STEM Pre-Academy

GOOD JOB!

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Data Collection

https://docs.google.com/spreadsheets/d/12QUj2cWrxlHfWXER78riuaYUCQcYmSIOBBpPzy6UzHM/edit?usp=sharing

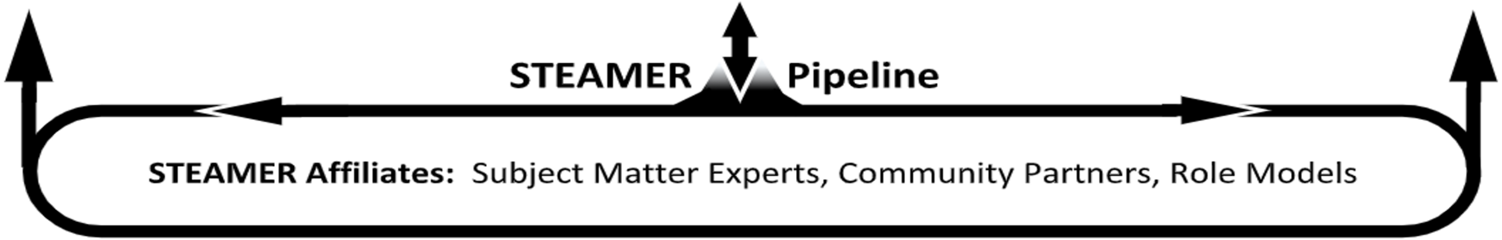
Driving Question

Given a budget, how can we, as a design team, plan a functional hydroponic system for clients (teachers) to use in the indoor/outdoor?

Client Interview

"Build relationship with client to care what client thinks"

KA'IMILOA ELEMENTARY	Ilima Intermediate	James Campbell HIGH SCHOOL	'Ilima AT LEIHANO
Mr. Agatrap - Teacher Mrs.Kawelo - Teacher	Ms. Arakawa - Science Teacher Ms. Piecuch - Cooking	Ms. Watari (NR Core, Biotech /Productions teacher - Ag. Teacher)	Assisted Living for Residents



Jason Akamine (Washington Middle School)

Ken Kozuma - Waipahu Intermediate School

Cheryl Ishii and STEM Pre-Academy Team

Jason Akamine (Washington Middle School)

STEM Pre-Academy Interns

Jensen Uyeda - CTAHR UHM

Stacie Sasagawa - Bayer

Dr. Aaron Hanae - KCC Engineering

Expert Interview

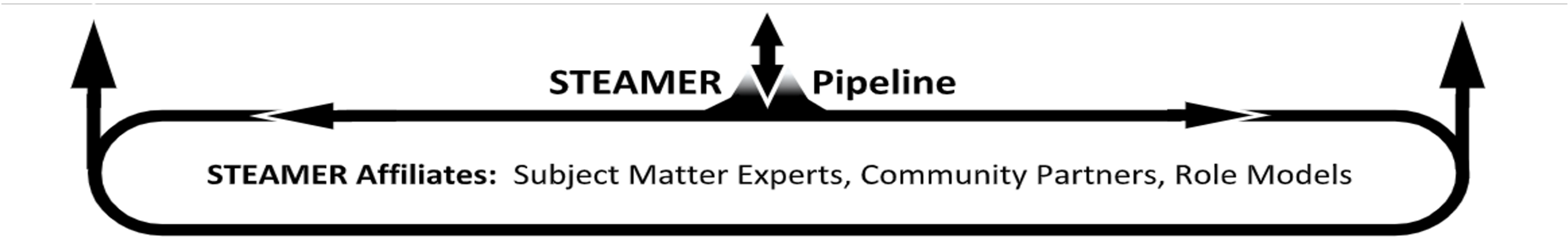
“Build Knowledge, Understanding, & Skills to Answer Driving Question”

- Jensen Uyeda - UHM
  - What is hydroponics? What is the Kratky System?
  - Common problems with hydroponics plants? Or nutrients?

Client Interview

"Build relationship with client to care what client thinks"

Ka'imiloa Elementary	'Ilima Intermediate	James Campbell High School	'Ilima at Leihano
Mr. Agatrap - Teacher Mrs.Kawelo - Teacher	Ms. Arakawa - Science Teacher Ms. Piecuch - Cooking	Ms. Watari (NR Core, Biotech /Productions teacher - Ag. Teacher)	Assisted Living for Residents



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Resources

Performance Expectations (PEs) to address Disciplinary Core Ideas (DCIs) **(Evidence Statements are in parentheses)**	**Instructional Ideas for Hydroponics Project**
MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (ES)	*Students compare seedling growth in different settings and interpret how the flow of energy and matter may have impacted it. Models can include drawings, videos, posters, etc.*

Science & Engineering Practices (SEPs)	Instructional Ideas for Hydroponics Project
Asking questions and defining problems includes specifying relationships between variables, and clarifying arguments and models.	Students will ask questions that arise from careful observation of the growth of plants in the seed germination system.
Developing and using models includes developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.	Students will develop models related to seed germination design systems and plant growth, including both observable and unobservable mechanisms.
Planning and carrying out investigations includes investigations that use multiple variables and provide evidence to support explanations or solutions.	Students will carry out an investigation for seed germination under different variables (e.g., light levels, seeds, fertilizers), collect data, interpret their results, and provide reasoning for their explanation.
Analyzing data includes extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	Students will analyze plant growth data, including quantitative measurements and qualitative observations.
Using mathematics and computational thinking includes identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.	Students will use spreadsheets to analyze plant growth data for patterns and trends.
Constructing explanations and designing solutions includes experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.	Students will construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) seed germination phenomena.
Engaging in argument from evidence includes constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).	N/A
Obtaining, evaluating, and communicating information includes evaluating the	Students will communicate scientific and/or technical information (e.g. about a proposed

Crosscutting Concepts (CCCs)	Instructional Ideas for Hydroponics Project
Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.	*Students will use graphs, charts, and images to identify patterns in data, including cause and effect relationships.*
Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.	*Students will use cause and effect relationships to predict phenomena in natural or designed systems.*
Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.	*Students will manage scale, proportion, and quantity as they investigate the seed germination system, conduct investigation of plant growth, collect data, and analyze data.*
Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.	*Students will develop and use models to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.*
Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior	*Students will observe plants growing over time and reflect on the flow of energy and matter that made that happen.*
Structure and Function: The way an object is shaped or structured determines many of its properties and functions.	*Students will examine how structure affects function within the plant and seed germination system.*
Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.	*Students will manage stability and rates of change as they investigate the seed germination system, conduct investigation of plant growth, collect data, and analyze data*

Ilima Intermediate School - Quarters 2, 3, 4

Hydroponic Option for Teachers

Select one option:

- Each student group will work with you to create a prototype that will work for your classroom needs! The option that you choose can be modified to support your needs in the classroom.

Option 1:
Tabletop Hydroponics

Option 2:
Mobile Cart (Blue Rubbermaid-Style): Mobile because it has locking wheels but not as transportable

Option 3:
Portable Carts: Portable because the cart can fold up and stored or transported easily.

Option 4:

Your own idea!

Note: Sensors will not be included in the prototypes that you will receive. However, sensors can be borrowed from the STEM Pre-Academy.

Performance Expectations (PEs) to address Disciplinary Core Ideas (DCIs) **(Evidence Statements are in parentheses)**	**Instructional Ideas for Hydroponics Project**
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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. (ES)	*Students will define constraints and specifications needed for their classroom hydroponics design. They will research existing designs and determine which features would best align with their classroom hydroponics design needs.*
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (ES)	*Students will show clients their design to evaluate how well the designs meet the constraints and specifications.*
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. (ES)	*Students will test their prototype designs, collect data, analyze data, and provide justifications for which design features should be kept, modified, or removed.*
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. (ES)	*Students will iterate their prototype to complete an optimal design.*

Science & Engineering Practices (SEPs)	Instructional Ideas for Hydroponics Project
Asking questions and defining problems includes specifying relationships between variables, and clarifying arguments and models.	Students will ask questions that arise from careful observation of the growth of plants in the hydroponics system and question the relationship between dependent and independent variables.
Developing and using models includes developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.	Students will develop models related to hydroponics design systems and plant growth, including both observable and unobservable mechanisms.
Planning and carrying out investigations includes investigations that use multiple variables and provide evidence to support explanations or solutions.	Students will plan an investigation to compare the growth of plants with different variables (e.g., light levels, fertilizers), collect data, interpret their results, and provide reasoning for their explanation.
Analyzing data includes extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	Students will analyze plant growth data, including quantitative measurements and qualitative observations.
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Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.	*Students will use graphs, charts, and images to identify patterns in data, including cause and effect relationships.*
Cause and Effect: Mechanism and Prediction: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.	*Students will use cause and effect relationships to predict phenomena in natural or designed systems.*
Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.	*Students will manage scale, proportion, and quantity as they build their hydroponics system, conduct investigation of plant growth, collect data, and analyze data.*
Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.	*Students will develop and use models to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.*
Energy and Matter: Flows, Cycles, and Conservation: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior	*Students will observe plants growing over time and reflect on the flow of energy and matter that made that happen.*
Structure and Function: The way an object is shaped or structured determines many of its properties and functions.	*Students will examine how structure affects function within the plant and hydroponics system.*
Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.	*Students will manage stability and rates of change as they build their hydroponics system, conduct investigation of plant growth, collect data, and analyze data*

Literature Cited

Kratky, B. A. (2010). A suspended net-pot, non-circulating hydroponic method for commercial production of leafy, romaine, and semi-head lettuce. *Vegetable Crops, VC-1*, 1-19.

Kratky, B. A. (2004). A suspended pot, non-circulating hydroponic method. In *South Pacific Soilless Culture Conference-SPSCC 648* (pp. 83-89).