Young Minds Collaborate to Engineer Food for the Future

Jennifer Chambers & Jose-Luis Izursa

The Siena School prepares bright, college-bound students with language-based learning differences to become confident, curious learners who understand their personal strengths and gain the tools and strategies to excel.

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The Department of Environmental Science and Technology

ENST's mission is to prepare professionals on the fundamentals of environmental science, while instilling a deep fascination and intellectual capacity to work in different areas of specialization:

- Ecological Technology Design
- Ecosystem Health
- Soil and Watershed Science
- Natural Resources Management

When our students graduate, we want them to be top-notch environmental stewards with a broad framework from which they can advance professionally, personally and socially.

Who we are?

Jennifer Chambers

- Teaches 7th & 8th grade Science
  - Physical Science
  - Life Science
- Math/Science Department Chair
- Environmental & Outdoor Education Coordinator

Jose-Luis Izursa

- **Teaching**: CAD for Ecology and International Crop production
- **Advising**:
  - Academic
  - Green Roots Club
  - MANRRS
  - Rotaract
- **Research**: Sustainable food production systems

Guiding Question

How do we facilitate and create partnerships to support higher and secondary education students in authentic problem solving to reduce food insecurities in the United States?

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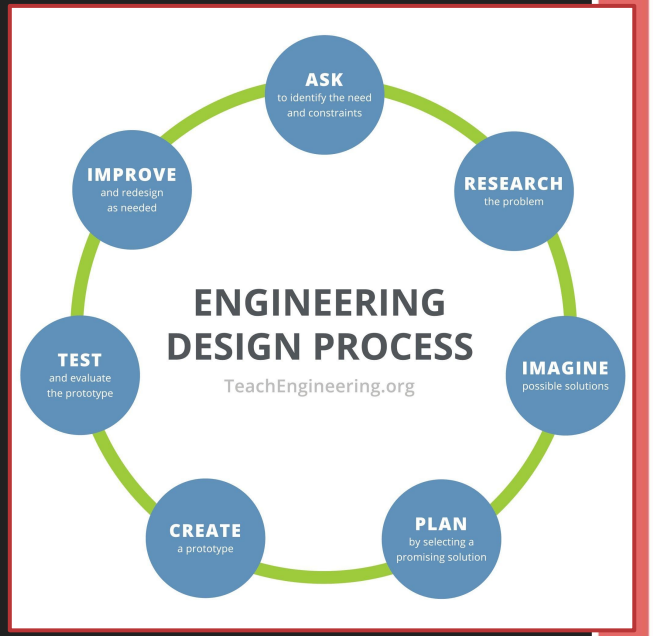
Instead of a Science Fair...



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SCI-CON

Let your imagination soar!

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Engaging Students with Learning Challenges

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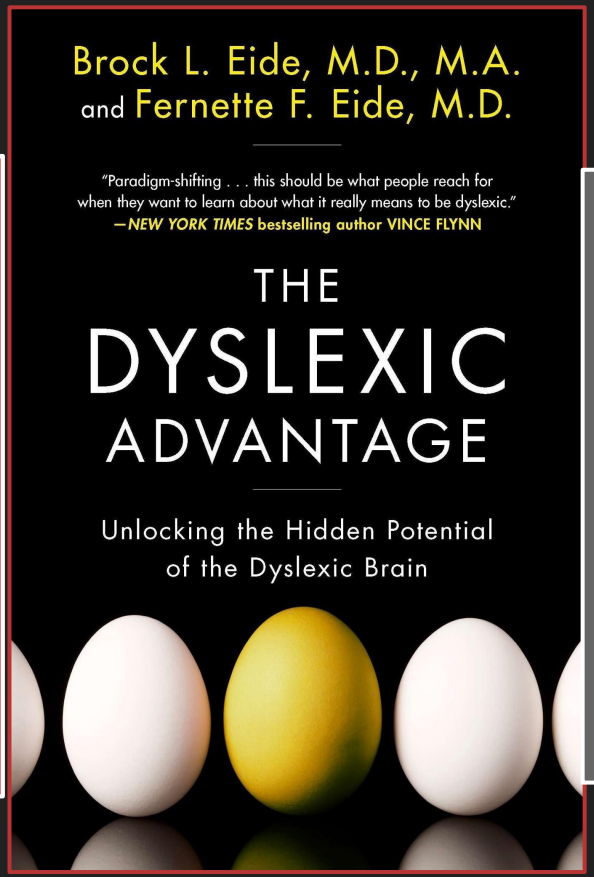
Let your imagination soar!



MIND Advantage

M - Material reasoning

I - Interconnected reasoning

N - Narrative reasoning

D - Dynamic reasoning

Last year's SciCon was...

Guiding Question

How can food be grown sustainably to reduce the impact on the environment while meeting the needs of an increasing population?

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Last year's SciCon was...

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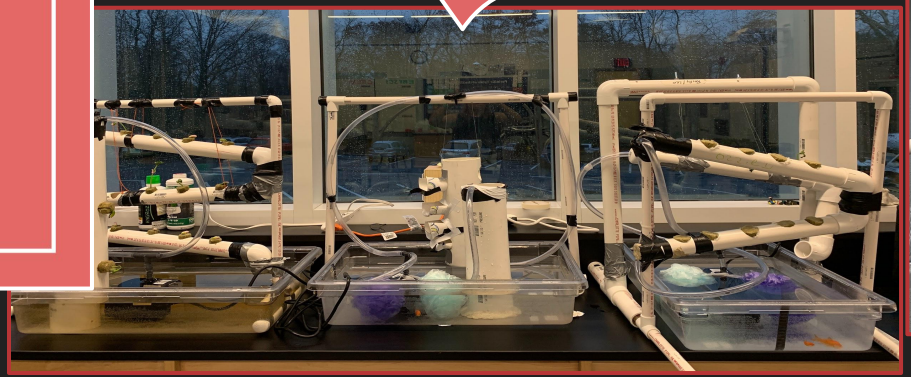
SCI-CON

Let your imagination soar!

Aquaponics & Hydroponics



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Seeking help...

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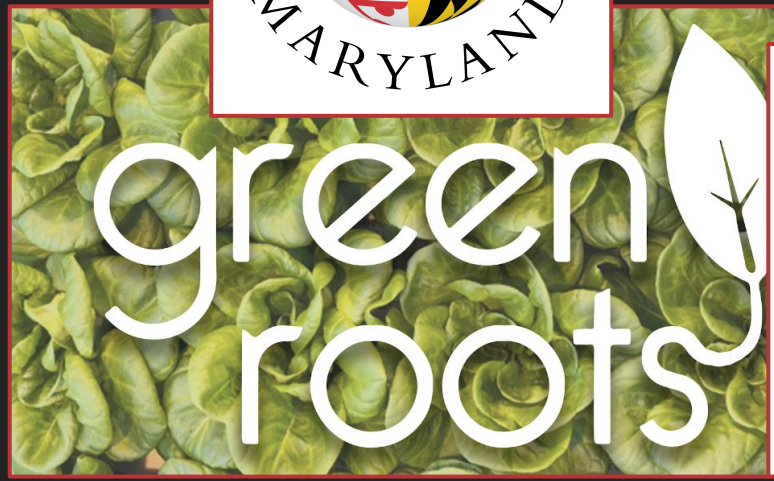


Current Issues with Traditional Agriculture

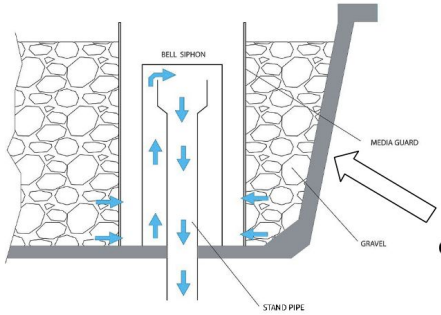
- 70% Fresh Water
- Land Misuse
- Harmful Pesticides
- Ecosystem Devastation
- International Transportation

green roots

Our Systems

2

Ebb/Flow & Lettuce Raft (in prog.)



https://worldwaterreserve.com/aquaponics/bell-siphon-for-aquaponics/

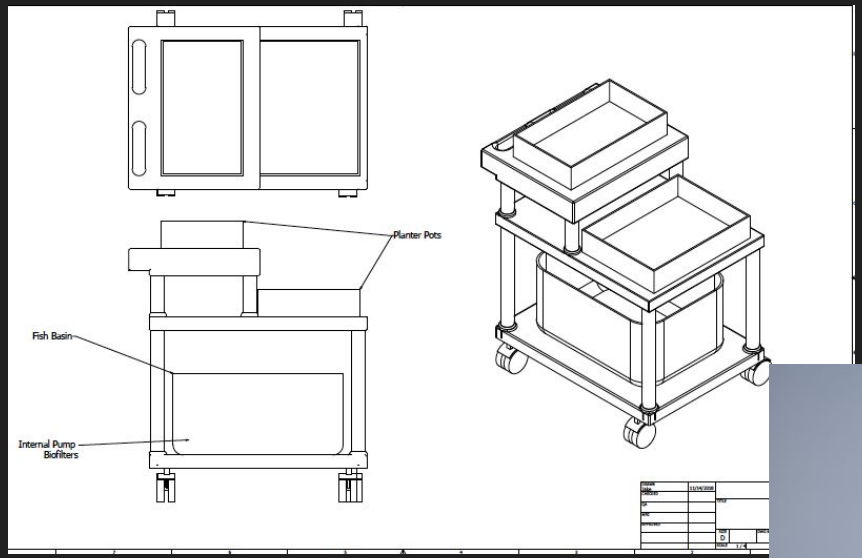
green roots

MATA - Mobile Aquaponic Teaching Assistant

How MATA was conceived?

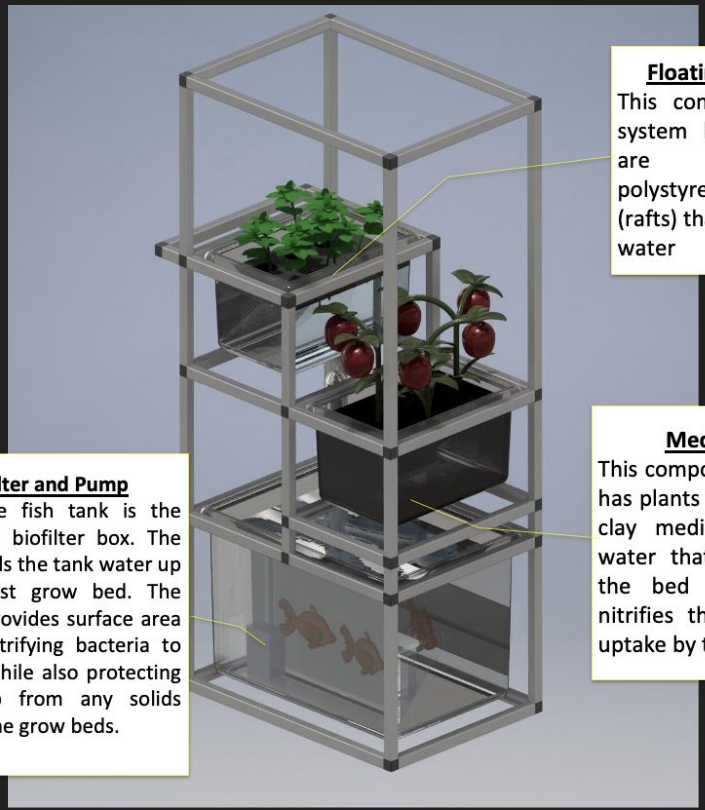
- Proposed as a capstone project
- Project main goal:
  Design, prototype and fabricate a “novel” mobile aquaponic system used for teaching in a classroom environment (Elementary, Middle or High School).
    - System Requirements:
      - Show all parts and components
      - Fit in a media cart
      - Look very nice
      - Apply for a patent

From trash to showroom



MATA - Prototype I

From trash to showroom

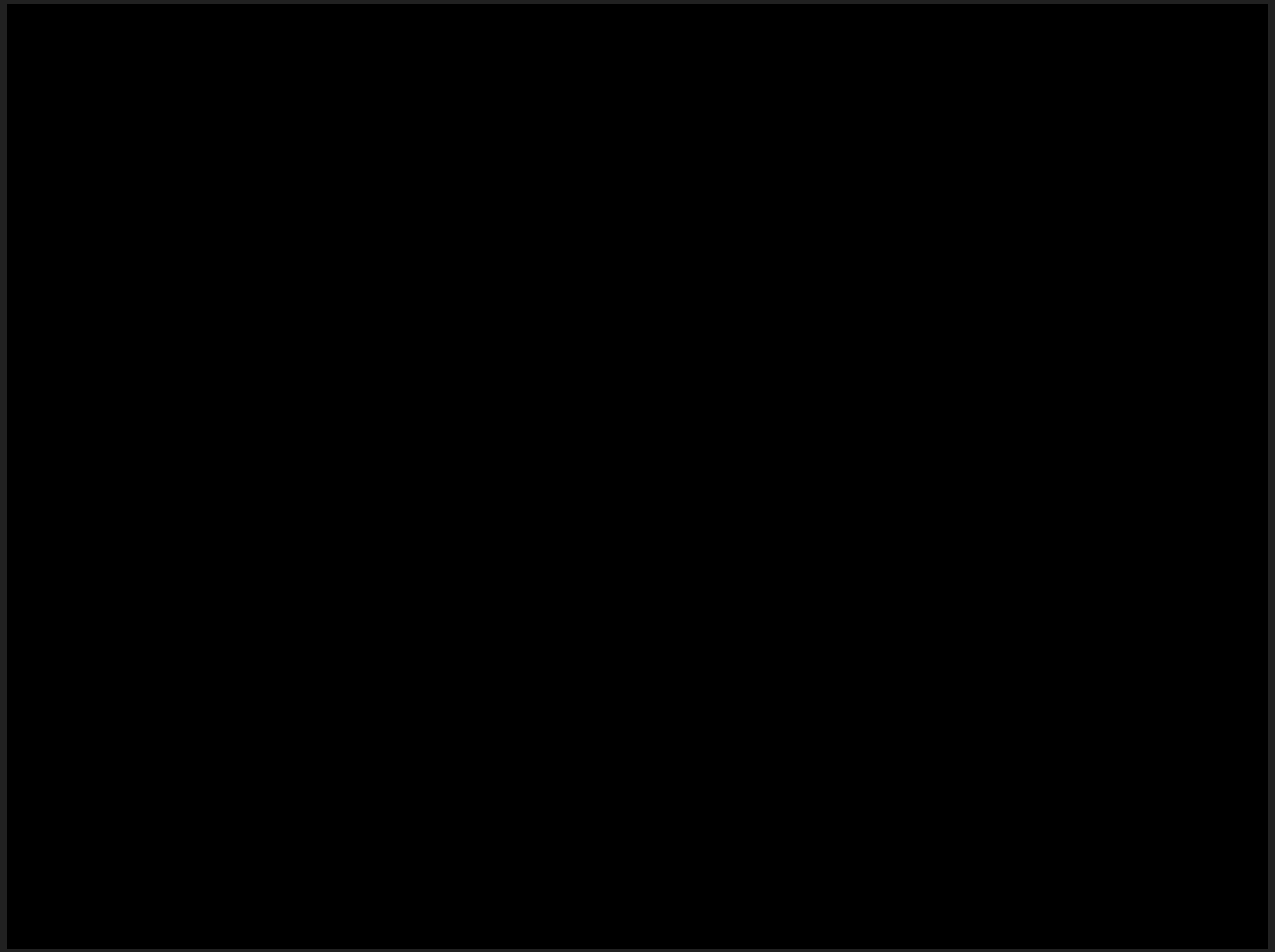


Floating Water Bed
This component of the system has plants that are grown on polystyrene boards (rafts) that float on top of water

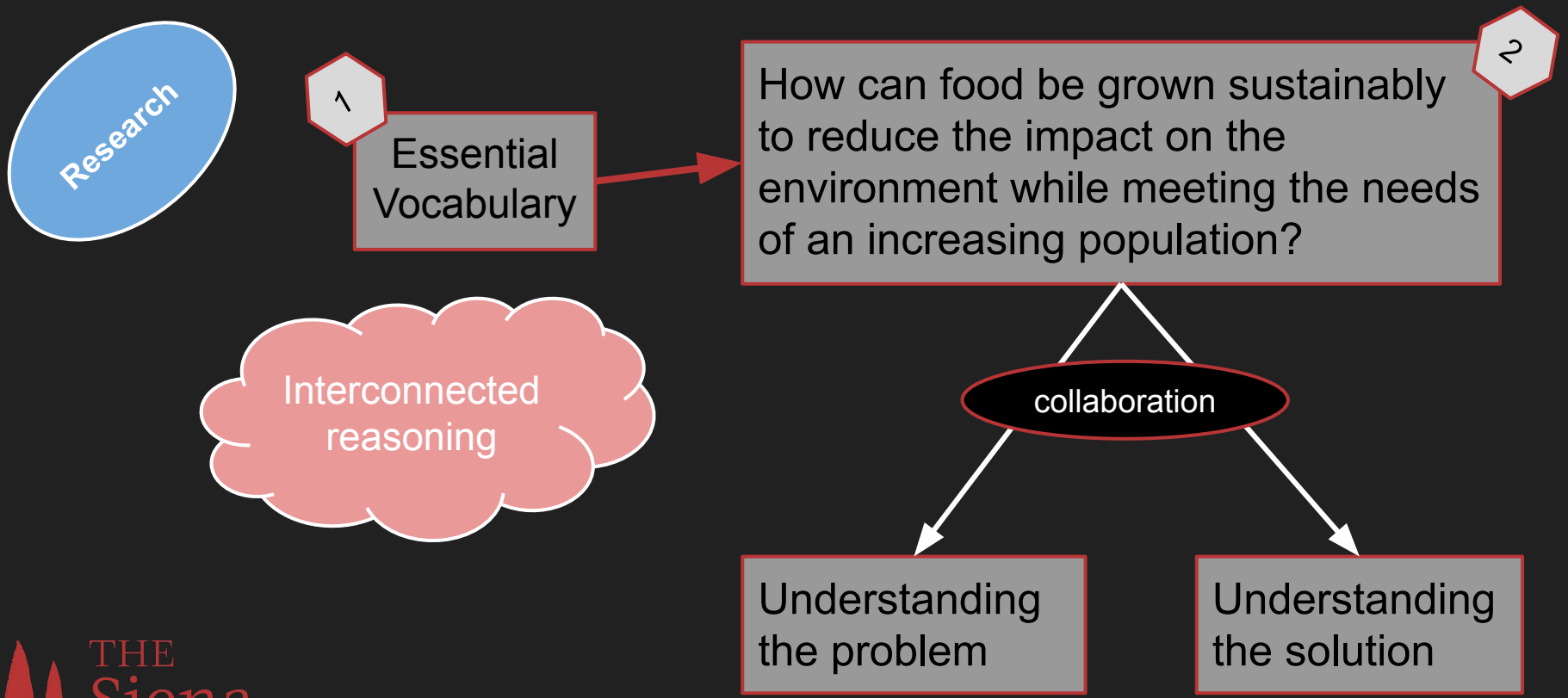
Media Filled Bed
This component of the system has plants that are grown in a clay media bed. Here, the water that enters, saturates the bed and the bacteria nitrifies the ammonia to be uptake by the plants.

Biofilter and Pump
Within the fish tank is the pump and biofilter box. The pump sends the tank water up to the first grow bed. The biofilter provides surface area for the nitrifying bacteria to colonize while also protecting the pump from any solids entering the grow beds.

MATA - Prototype II



What does STEM learning that look @TheSienaSchool?



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Imagine & Design

Design Constraints	Design Criteria	Constants	Quantified Data
• Limited materials • Time • No rain • Indoor growing • Maximum 60cm x 60cm system	• Vertical system • Use recycled materials • Maximize growing surface area and system surface area • Self-sustaining • Deliver nutrients in a closed system • System can't leak outside the bin/tub • Grow beans • Keep fish alive (aquaponics only)	• Tray and pump under the system • Amount of water in the tray • Amount of nutrients or fish • Growing beans • Water flow rate • Materials provided	• System surface area • Growing surface area • Ratio between growing and system surface area • Dissolved oxygen • Change in tray water height • Nitrates/phosphates - aquaponics only

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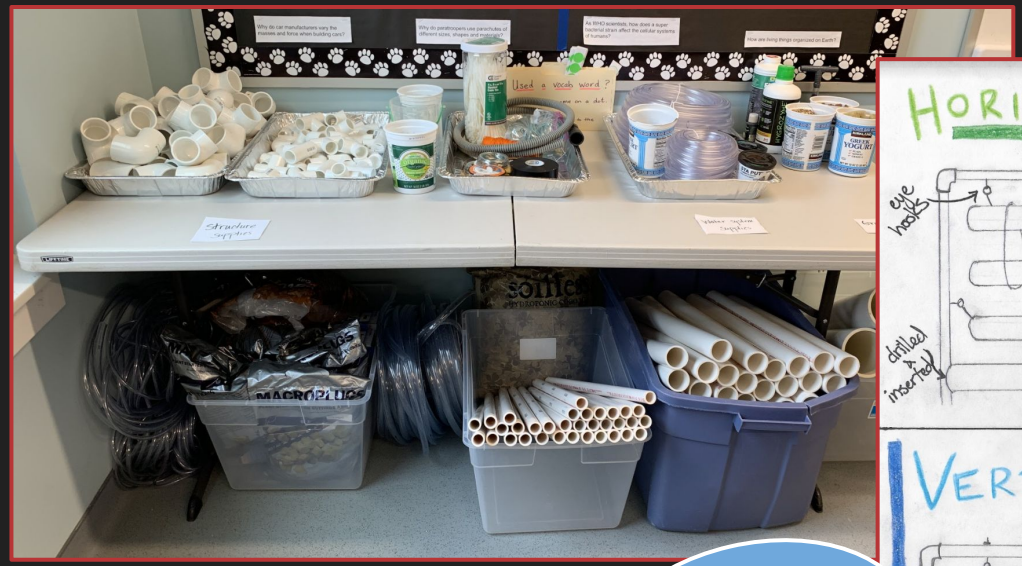
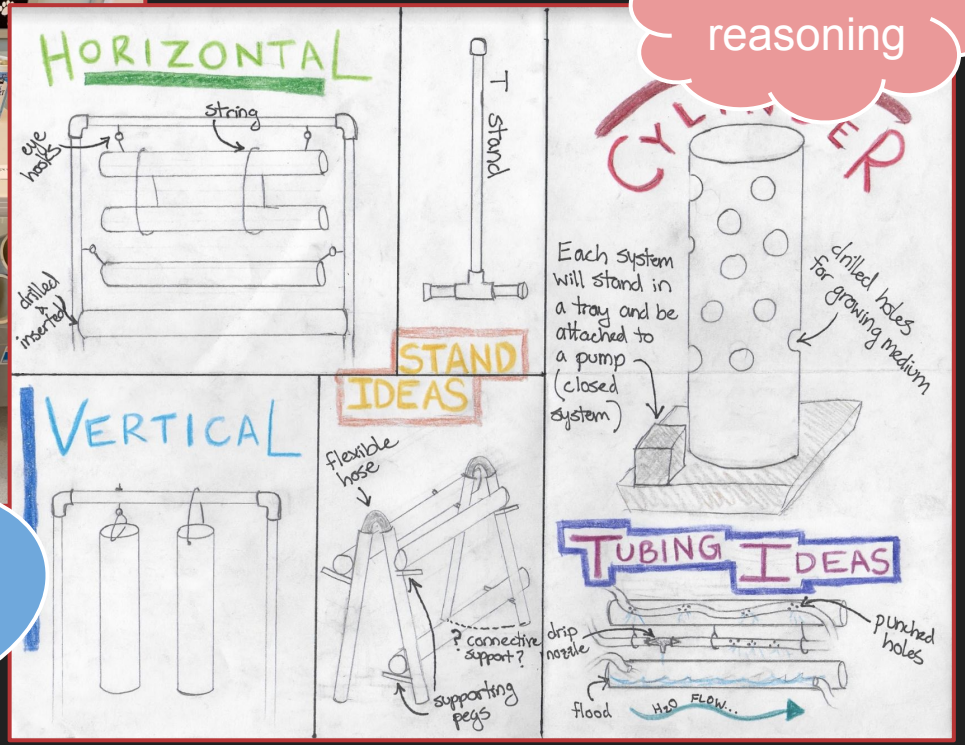


Material reasoning



Imagine & Design

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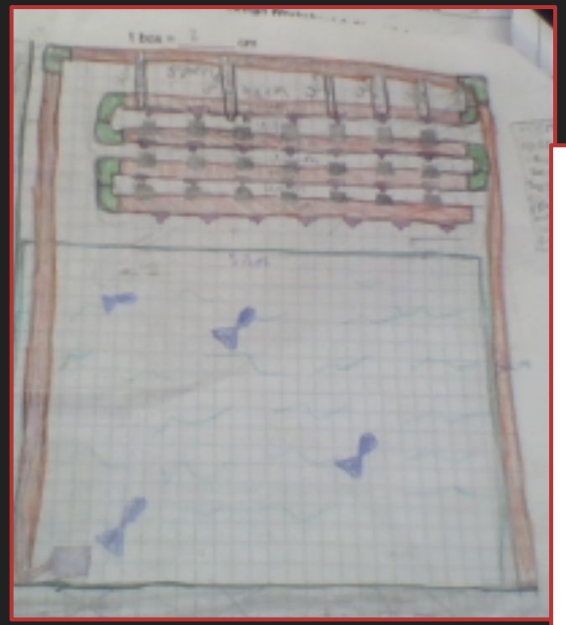

Imagine & Design

Design Checklist

Draw/Labels (30 pts)	Measurement (20 pts)	Materials (20 pts)	System Part	Feedback
			Drawing One	
			System Structure • How will the system stand vertical? • How will the system support the growing surfaces? • What is your water source and catchment?	
			Growing Surface • Which system - vertical, horizontal, angled or tower? • How will it attach to structure? • Holes for growing plants?	
			Drawing Two	
			Water Delivery (includes pump & tubing) • How will you deliver water to your plants? • How will you run the tubing from the pump through the system back to the pump?	
			Growing Medium • Which medium will you use? • Where is it placed on your growing surface?	

Material reasoning

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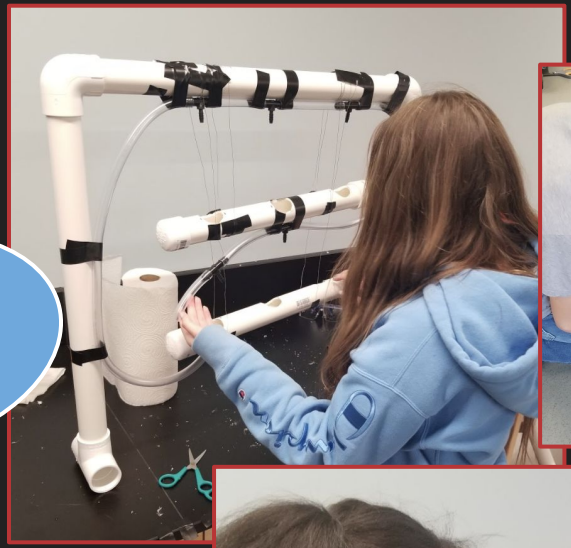
Build, Test & Improve



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SciCon Engineering Journal - 2019

Goal

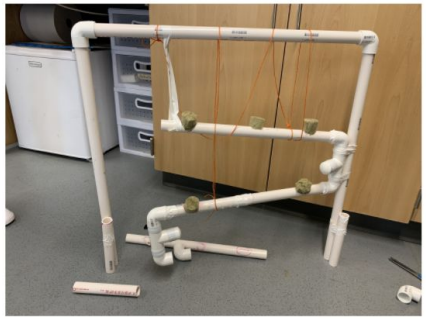
You will use this electronic engineering journal to keep your information, thoughts, photos, videos and notes to help you design, build and test your hydroponic or aquaponic system and then create your SciCon story.

Date - 2/11/20

Build, Test & Improve

Describe what you did to build or improve your system.

- We created one more hole in one of ou r44cm PVC pipes and decided to to stop cutting holes for our growing medium(rock wall) to go into Since we don't have a lot of time
- In total we have 5 holes cut out in hopes of being able to yield one plant from each growing medium (rock wall)(originally we wanted to have nine holes in three 44cm PVC pipes)
- We got 5 rock walls (our growing medium) and put each one in the the holes that we made with the hot glue guns to germinate our seeds in
- We assembled our system structure by taking three 60cm PVC pipes and two elbow PVC pipes and connect them together
- We resemble our water delivery system and growing structure by taking our 44cm PVC pipe that had three pieces of rock wall in the PVC pipe and attached one end of the PVC pipe to one end of one of the elbow T-PVC pipe that we made a few days ago and then we connected the other 44cm PVC pipe that has two rock walls in it to the other end of the Elbow T-PVC pipe and then connected the other end of the 44cm PVC pipe that has two rock walls in it to the other elbow T-PVC pipe and left the other end of the elbow T-PVC pipe open for the water to go out of
- We used electrical tape and nylon rope to connect the growing structure/water delivery system to the system structure



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Dynamic reasoning

Build, Test & Improve

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Build, Test & Improve

Testing Only

Date - 2/12/20

1. **What are my system's successes?** The aquaponics system is stable and the water flowed through the whole system.

2. **What are my system's limitations?** The flow rate of the water excessive which caused more water to come out of the leaks. The electrical tape made leaks worse because the water from the leaks traveled through the tape and spilled out in a lot of different areas then wear the leaks were wich made it hard to tell were the leaks were coming from.

3. **What will I change to improve my system?** We are going to use plumbers putty to patch all the leaks and and use a toob t-drip to make the flow rate of the water slower.

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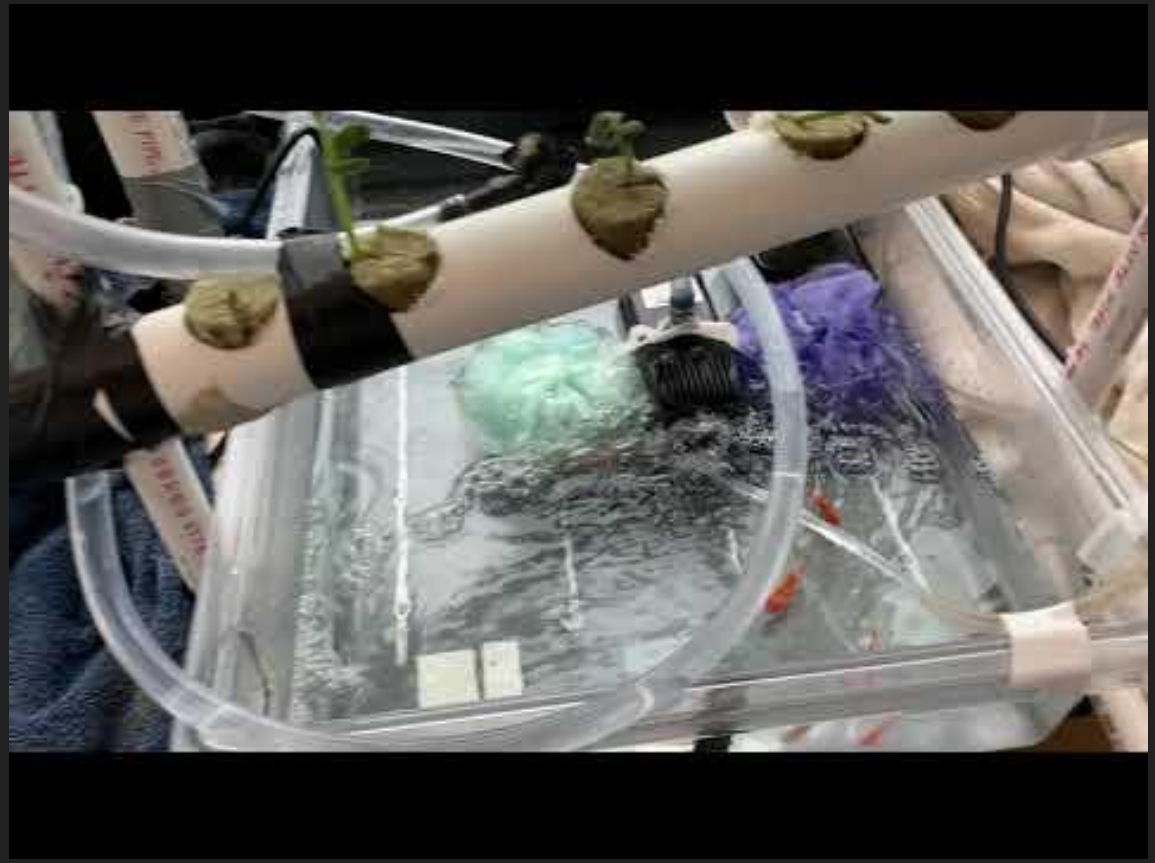
Build, Test & Improve



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SciCon Final Narrative Grading Rubric

Needs growth	Criteria	Glows	Points

	Vocabulary (30 points)
	• Use 12 different vocab words accurately
	  ○ 5 from primary list
	  ○ 7 from secondary list
	• Use them in your script/notes to tell the story		

	Engineering Process (30 points) • Explain the problem • Explain designing, building, testing and improving in detail using "because" statements		
	Story Line (25 points) • Attention-grabbing story starter • Organized story • Graph and explain the data • Stated overall successes & challenges		
	Communication (15 points) • Highly visual product • Strong, clear voice • Positive body language		

Narrative reasoning

Final Checklist - SciCon 2019-20

Peer Check Yes or No	Checklist Questions	Your Check Yes or No
	In my "**Story Starter**", do I… • Introduce my partner and myself, • Explain what we did, • Explain why we did built a hydro/aqua system and • State when and where we built our system?	
	In "**Understanding the Problem**", do I… • Explain the problems with current farming practices and how hydro/aqua systems grow plants?	
	Your System", do I explain how we built our ystem?	
	lem", do I... xplain a success for each test, xplain a limitation for each test and xplain an improvement for each test? m) explain the problem, m) explain why it was a problem and m) explain how we improved the problem?	
	o I… my team's growing medium volume and surface area data, re our data to another team's, ta and units of measurement in my explanation	

Slides Graphic Organizer - Hydro/Aqua Systems: SciCon Narrative

Slides #	Plan	Notes/Index Card	Images/Video
	Story Starter • Who was on the team? • What did you do? • When? • Where?		
	Understanding the Problem • What are the problems with current farming practices? • What are the global environmental problems that hydroponic/aquaponics solves? • How do plants grow in a hydroponic/aquaponic system?		

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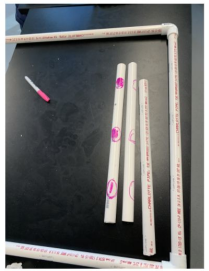
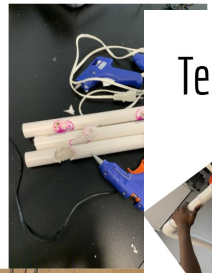
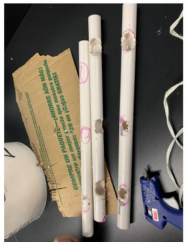
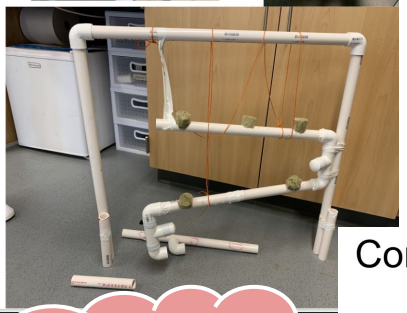
building my system

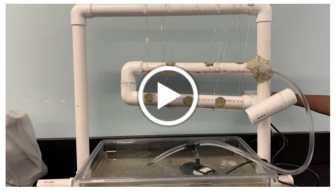
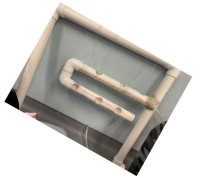
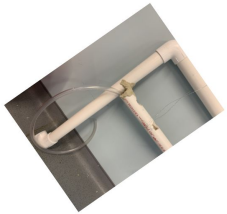





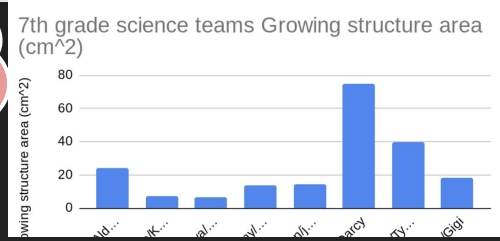


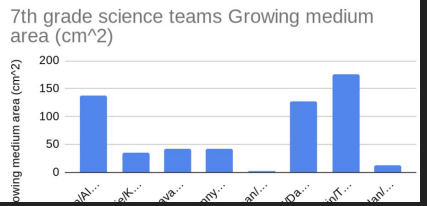
Test one



Comparing Teams





Narrative reasoning

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UMD & Siena School Partnership

- Continue support on Engineering Design Process
- Bring a MATA system onto the Siena school to improve design
- Curriculum development based on MATA

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