transform.ed

# Ento.Ed

## Open Source Mealworm Farming Curriculum



Developed by:

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In Partnership With:

Little Herds & El Paso Leadership Academy

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## Lessons:







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## CURRICULUM OVERVIEW: CULTIVATING THE WHOLE CHILD

"In times of change, learners inherit the earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists." – Eric Hoffer

This curriculum strives to teach the whole person, facilitating each student's individual gifts and talents by cultivating critical thinkers that will be prepared to address the many issues facing their generation. The format and delivery of this curriculum will often break with convention. As can be seen from the very first lesson, students will not be told a concept and then asked to regurgitate through examples and repetition. Rather, students will find themselves getting their hands dirty which will ignite their curiosities through unconventional exploration, lively discussion, and direct application. Students and teachers will learn critical thinking and problem solving as it applies to any situation by engaging in group and individual hands-on projects. This curriculum seeks to place students consciously at the same vantage points as that of inventors and revolutionaries. It prepares them to look at problems and find well applied and creative solutions without the heavy influence of outside pre- and mis-conceptions. This curriculum relies on the notion that everything a child needs to learn is found within themselves and it is our job as teachers to simply facilitate and nurture that innate ability for each of our students.

***This specific piece of curriculum was originally designed for a group of 7th grade students in El Paso, TX and is included in a series of "blocks" that cover state standards through application of sustainable practices. The "Edible Bug" curriculum is part of the "Food & Water" block and as such, readers will see references to that block. Within the "Food & Water" block students learn about sustainable agriculture and rainwater harvesting as they replace their school's parking lot with an edible food forest complete with nutrient-dense fish ponds. During the "Energy & Transportation", students begin by soldering solar panels and then take those foundational concepts to create a solar powered shade structure that will power electric bikes. Finally, in the "Green Architecture & Governance" block, students learn about sustainable and appropriate architecture as it applies to their specific climate through construction of greenhouses using local materials, weatherization of existing infrastructure, and calculating and comparing the embodied energy of resources such as concrete vs. adobe. They then jump on their electric bikes and present to City Hall and government offices on issues surrounding food, economic, and social justice. We hope you enjoy and use this small segment of curriculum to help kick-start the conversation of sustainability amongst your students, good luck and bon appetit!****



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## OBJECTIVE: STANDARDS AND GROUNDING QUESTION

7th Grade students are required by the state of Texas to develop certain skills. These standards are typically segregated by discipline. In English, we ask students to develop reading and writing skills, implement research plans, and learn oral and written convention. In math, we expect students to apply problem-solving models, expand their mathematical processing skills, and delve into proportionality and financial literacy. In social studies, we explore the history of Texas through a wide lens that considers national and international influences on state development. And in science, we primarily focus on organisms and the environment while simultaneously taking a good look at the principles that govern Earth, space, matter, and energy.

These are all wonderful skills to develop, but the approach of this curriculum is to teach these important concepts through an integrative process that has students fully learn each subject and how to apply it in real world contexts that integrate the disciplines. If we teach through real application, students begin to see how these disciplines interact, overlap and connect. And we, as teachers, begin to see and teach from that same "big picture perspective" as we learn and bear witness to the variety of passions and abilities that make up our student population. We don't know what the next generation of jobs will be and we don't know what the world will look like 50 years from now. Cultivating and celebrating variety in our youth will help prepare them for the many challenges they will face in the years to come.

**With that goal in mind, this curriculum will ground itself around a single question that will serve as fertile ground for all disciplines to be explored: "What does a symbiotic society require and what role can we play in its creation?" Students will continually revisit these explored concepts at ever growing levels of complexity. This will give focus, intention, and purpose to the class material as students look at water, food, health, governance, transportation, energy, economy, and the built environment. This guiding question will open possibilities at all grade levels, but specifically in 7th grade, students will primarily be looking at the components of energy and transportation.**





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## FOOD & WATER BLOCK

Along with shelter and clothing, food and water make up the traditional basic needs that we, as humans, require for survival. While the transform.ed curriculum explores additional "rights" of every human, this block specifically focuses on addressing these two basic needs. Students will explore traditional standards such as area and volume, slope, water dynamics, historically documented irrigation methods used in the Southwest, and principles of economics while creating site maps that designate water and energy flow, building ollas, working with photo overlays and 3D renderings in SketchUp, and building interconnected systems for capturing rainwater and growing food, even raising insects as food. This is the first phase of urban gardening and landscaping of school grounds in which students will play an active role, both in designing and implementing.

Assignments will center on explicitly conveying covered concepts in direct relation to site planning and design. Students will scale up architectural drawings to create a project site map, adding cohesive elements to as they move through the curriculum. Soil analysis will allow students to plot the impact of rehabilitation efforts and prepare presentations for similar "parking lot" conversions throughout El Paso. This data will be a part of a compilation of "baselines" that cohorts over the years will use as they address issues such as soil and water contamination, weatherization impact, energy use/cost, and biodiversity. Ponds to raise fish which produce nutrients and hold water for irrigation efforts will be constructed and initial plantings will take place. This is an exciting evolution of the curriculum in which students literally take their learning outside...





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## WHAT FOLLOWS

**The following pages outline specific lessons that make up one section of a complete 7th grade curriculum.**

In each lesson, you will find an overview/objective, material list, and additional resources when applicable, homework assignments, assessments, and standards that are covered within each lesson.

Each lesson is designed to stand alone, but follows a logical sequence to continually revisit and deepen the concepts being discussed. This is to allow for insertion of additional lesson plans that are inspired by Socratic discussions and each facilitator's unique knowledge/interest base.

**Final Note: Students will be expected to compile a "main lesson" book that documents and illustrates their work and lessons. This will include papers, artwork, research, formulas, visual representations of data, and other material, the goal being that each student has an individual portfolio demonstrating their experience.**





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## MEALWORM FARMING PROJECT OVERVIEW

With guidance from a project facilitator, students will construct a functional mealworm farming unit capable of producing 2-20 pounds of food grade mealworms per month. No prior knowledge of entomology or entomophagy (eating insects) is necessary for the successful execution of this project as mealworms are a very low maintenance livestock and all necessary background materials are provided. By the second mealworm harvest, students and instructors will be well versed in entomophagy concepts and mealworm farming techniques.

Lesson plans 1 - 6 will establish production in a climate controlled environment. Once established, farming maintenance is minimal and follow up lessons on data collection for yield analysis will be supplemented. In the spirit of an open source curriculum, we look forward to user feedback, additions, and modifications.





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## LESSON 1: INTRODUCTION TO ENTOMOPHAGY

### OBJECTIVE:

The objective of this lesson is to give students a broad introduction to the world of edible insects. Students will understand global insect consumption, the future food crisis, sustainability of mini-livestock, and the Western view of entomophagy. A math activity will be used to illustrate how common insects show up in processed foods. Students will then be given a brief introduction to their mealworm farming project.

### NECESSARY MATERIALS:

1. Projector for video and presentation
2. PDF of Why Not Eat Insects
3. Printed copies of grow bag sewing pattern
4. Grow bag raw materials: no-see-um netting, 1 inch fabric tape (or ribbon) and thread
5. Batch of chocolate chip cookies made with cricket flour
6. Student laptops

### LESSON SCHEDULE GUIDE:

1. (15 min) **Watch Marcel Dicke's TED Talk about Entomophagy**
    a. Pass out cricket cookies.



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2. (30 min) **Facilitator-Led Presentation about Entomophagy**

3. (20 min) **Entomophagy Discussion / Q and A**

4. Break

5. (65 min) **"Bugs in your Grub" Math Project**
    a. Visit FDA Food Sanitation Page.
    b. Work in groups or on your own.
    c. Answer questions about insect parts in processed foods

6. Break

7. (45 min) **Brief Overview of Mealworm Farming Project**
    a. Why this is important in our community.
    b. Brief discussion of farming method.
    c. Enlist parent / relative sewing help with rearing bags.
        i. Hand out copies of pattern for grow bag and pass around a sewn grow bag if available.
        ii. This Wiki page provides great step by step sewing instructions.

## HOMEWORK:

1. Read Part 1 (pages 1-31) of Why Not Eat Insects?
    a. There will be a reading comprehension quiz tomorrow.





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## LESSON 2: INTRODUCTION TO MEALWORM FARMING

### OBJECTIVE:

The objective of this lesson is to give students a clear picture of mealworm biology, where they are naturally found, and how they are farmed. Students will also be broken into farming groups and given an overview of available materials and what they need to buy, borrow, or make to achieve successful mealworm yield. Then students will create a farming timeline poster based on mealworm farming literature.

### NECESSARY MATERIALS:

1. Student laptops
2. Poster paper
3. Printed pop quiz from Why Not Eat Insects
4. Grow tent - 63x31x31 recommended
5. Humidity and temp sensor and display - if available
6. Humidifier

### LESSON SCHEDULE GUIDE:

1. (15 min) Entomophagy Quiz 1 on Why Not Eat Insects Part 1

2. (60 min) **Assemble Grow Tent - Climate Control Lesson**
    a. Draw attention to climate of house (low humidity) with humidity sensor (if available)
        i. Hold sensor near toilet or open water source to see if reading changes.
        ii. Alternatively, if you have no sensor assemble grow tent, set up humidifier inside and have students feel difference with humidifier running in small space.
        iii. Note: Lesson assumes operation in an arid climate - humidity control may not be necessary in less arid regions.
    b. Students assemble grow tent as a class or as a group
        i. This works well as a group of 10-12 students/tent.



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3. Break

4. (20 min) **Mealworm Farming Basics Discussion**
    a. What are mealworms?
    b. What is a natural mealworm habitat?
    c. Discuss mealworm life cycle.
    d. What do mealworms need to thrive?

5. (65 min) **Students create mealworm farming poster**
    a. Students individually read the usage section of the Tiny Farms Guide (pg. 7-8).
    b. In farming teams create a visual timeline of important events in the mealworm life cycle and farming activities using a large piece of paper.
        i. Life cycle: egg, larvae, pupae, adult ...
        ii. Farming maintenance events.
        iii. Pictures and descriptions.
        iv. Time.
    c. This activity should cement a thorough understanding of mealworm farming practices that will be covered in future lessons.
    d. Students work in "temporary" farming groups in order to make changes, if necessary, before assigning permanent farming groups.




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## HOMEWORK:

1. Read Part 2 (pages 23 - 47) of Why Not Eat Insects?
    a. There will be a reading comprehension quiz tomorrow





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## LESSON 3: FARMING WITH THE SCIENTIFIC METHOD

### OBJECTIVE:

The objective of this lesson is to introduce students to the scientific method and its agricultural applications. As they establish their starter mealworms, students will conduct baseline mealworm measurements and then determine feed conversion ratios to improve efficiency. Students will also learn the importance of proper lab notebook procedures as they are introduced to their digital lab notebooks for the project.

### NECESSARY MATERIALS:

1. Projector for TED Talk
2. Student laptops
3. Kitchen scale
4. 4 lbs wheat bran (bulk section of grocery store)
5. Bag of carrots
6. 1000 - 1500 large mealworms
7. Printed Entomophagy Quiz #2

### LESSON SCHEDULE GUIDE:

1. (15 min) **Reading Comprehension Quiz 2** on Why Not Eat Insects Part 2

2. (20 min) Watch Caleb Harper's TED Talk "This computer will grow your food in the future"
    a. Learn about precision farming technologies.
    b. Explain to students that they will strive to make their mealworm farm this informative so that they can help improve knowledge of mealworm farming as a novel agricultural practice.

3. (30 min) **Mealworm Farm Group Assignment**
    a. Break students into groups (3 -5 students / group).
    b. Explain that each group will be responsible for 1 bin and 1 -2 growbags.
    c. Have students pick a name for their farming group.
    d. Share digital lab notebooks and explain how to keep a good laboratory notebook.
        i. Each group should make a shared copy of this notebook for themselves.

4. Break

5. (120 min) **Farming Begins!**
    a. Each team washes and labels their starter mealworm bin.





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b. Students weigh and add ~200g wheat bran to plastic bins and disperse ~47g carrots for moisture.
c. Spread starter mealworms on a large surface like butcher paper or a bin lid and have students remove dead mealworms by hand (these will be dark and shriveled).
d. Use grow bag or a sifter to separate mealworms from frass (bug poop) and old bedding.
e. Students divide mealworms into 4 equal parts using a scale.
f. Students record exact weight of added mealworms and wheat bran in lab notebook.
g. Groups add starter mealworms (F0) to bin containing wheat bran.
h. Bins are placed inside grow tent.

## HOMEWORK:

1. Writing: Blog entry - Why is data collection so important to the edible insect farming?



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## LESSON 4: EXPERIMENTAL DESIGN

### OBJECTIVE:

The objective of this lesson is to introduce students to experimental design concepts. Using the scientific method, students will create an experiment to answer a question about mealworm behavior with the intention of using the results to improve the farming process.

## NECESSARY MATERIALS:

1. Kitchen scale
2. Butcher paper
3. Apples, carrots, potatoes
4. Rulers
5. Other experimental props
6. Student laptops

## LESSON SCHEDULE GUIDE:

1. (20 min) Mealworm **observation and recording** in digital lab notebook - check on "mealies"
    a. How many dead mealworms did you find and remove?
    b. Where in the bin did you find most of the mealworms?
    c. Were the carrots nibbled?
    d. Other observations?

2. (25 min) **Review the Scientific Method**
    a. Explain: Hypothesis, Experimental Design, Observation, Objectivity, Analysis, Statistics, and Replication

3. Break

4. (45 min) **Experimental Design** to Improve Farming Process
    a. Based upon existing knowledge of mealworm farming, in farming groups, students come up with a list of 3 questions about the mealworm farming process that can be answered via a simple scientific experiment
    b. Example experiments:
        i. Will mealworms move toward the dark?
        ii. Will mealworms crawl toward a carrot?
        iii. Do they have a preference for carrots or potatoes?
        iv. Do they move away from vibration?
    c. Discuss proposed experiments with class and how many replications will be necessary.





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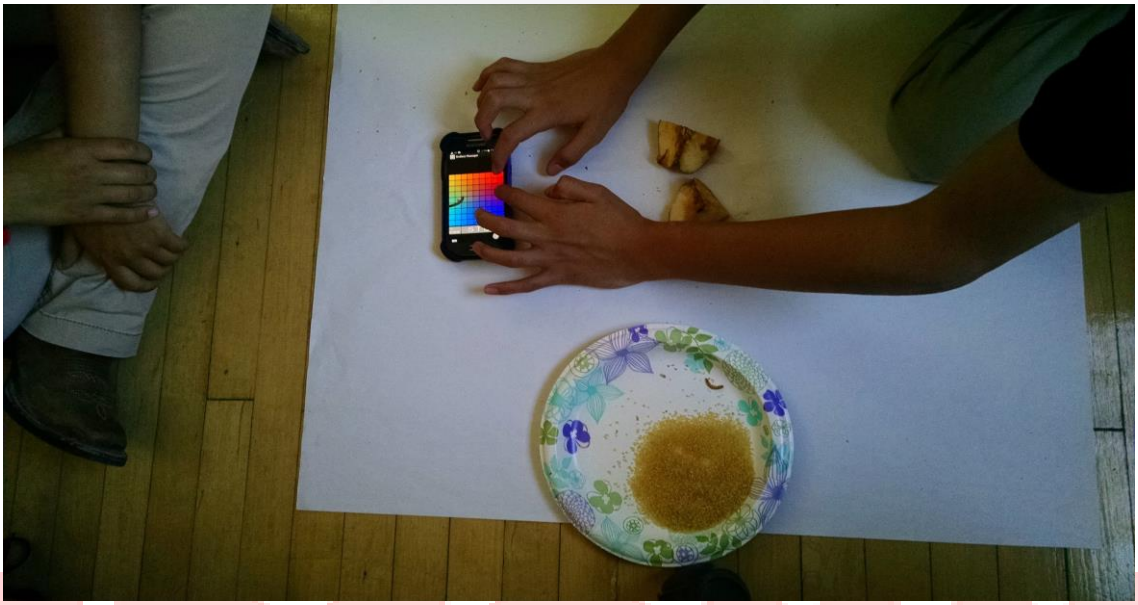
d. What are your experimental variables? Control variables?
e. Each group picks an experiment to perform and writes down a hypothesis and methods.

5. Break

6. (40 min) **Perform Mealworm Experiments**
   a. Each group performs experiment, recording results and observation in lab notebook.

7. Begin analysis if finished before the end of class





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## HOMEWORK:

(60 min) **Experimental Analysis**

1. Each group analyzes results
2. Each individual student writes a summary of the experiment, results and key findings and publishes it on their blog (~200 words).





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## LESSON 5: MEALWORM PLANNING

### OBJECTIVE:

The objective of this lesson is help students think ahead and make an appropriate plan for their mealworm farm based upon their current knowledge of mealworm farming. To help students think about how they might cook with mealworms and reinforce nutritional guidelines, students will create a mealworm meal plan. Then students will work as a group to plan and build the internal structure of the grow tent to incorporate as many mealworm grow bags and bins as possible.

## NECESSARY MATERIALS:

1. Edible insect cook books / recipe site
2. Student laptops
3. At least 50 ft >9mm cordage
4. Power drill
5. Power or hand saw
6. Spare plastic or light wood for shelves in grow tent

## LESSON SCHEDULE GUIDE:

1. (60 min) **Mealworm meal plan** - students create a full day diet including 100g mealworms
    a. Must stay within nutritional guidelines
    b. Share insect cookbooks with students for mealworm recipe ideas
    c. Use myfitnesspal website to look up and compile nutritional info
    d. Full day's meal plan posted into student blogs.



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2. Break

3. (15 min) **Mealworm observation**s - data recording in digital lab notebook

4. (45 min) **Group planning for the internal structure** of the mealworm habitat
    a. Reviewed components and the utilitarian needs of the habitat space.
    b. Students decide, as a group, how to best structure the inside of the mealworm grow tent to accommodate as many grow bags and bins as possible.
    c. Student designs must make use of only available materials.
    d. Likely materials will be provided to students such that can begin designing and executing internal structure using ropes.

5. Break

6. (60 min) **Students build internal structure**

## HOMEWORK:

1. Finish Mealworm Meal Plan blog post.





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## LESSON 6: THE INTERNET OF (BUG FARMING) THINGS

### OBJECTIVE:

The objective of this lesson is introduce students to sophisticated data collection methods for mealworm farming. Using a programmable Spark Photon IoT (Internet of Things) device, students will monitor humidity and temperature inside the mealworm grow tent. In real time students will be able to check mealworm climate via a live feed to their blogs. Students will then begin to build a knowledge base of the Internet of Things (IoT) by attaching a humidifier to a relay controlled Photon Spark. Students will learn the basics of adding a program that will allow for automatic climate control inside the grow tent based upon feedback from the temp / humidity sensors they have already installed.

### NECESSARY MATERIALS:

1. Photon with headers
2. Relay shield for Photon Spark
3. Charger cable for relay
4. Grove - Temperature Humidity Sensor Pro
5. Guest speaker from MakerSpace (i.e. FabLab)
6. Photon Code
7. Humidifier
8. Wire strippers
9. Wire snippers

### LESSON SCHEDULE GUIDE:

1. (60 min) **Intro to programming language: Play** Scratch
    a. Students use one of the step-by-step guides to write a program of your choice.
    b. Have them create their own project once they get the hang of it.
    c. Students share their creation with facilitator for participation credit.
    d. Students can embed Scratch project on their blogs for extra credit.

2. (50 min) Guest speaker from local MakerSpace to **Introduces IoT (Internet of Things)**
    a. IoT concept
    b. Demonstration of simple IoT device





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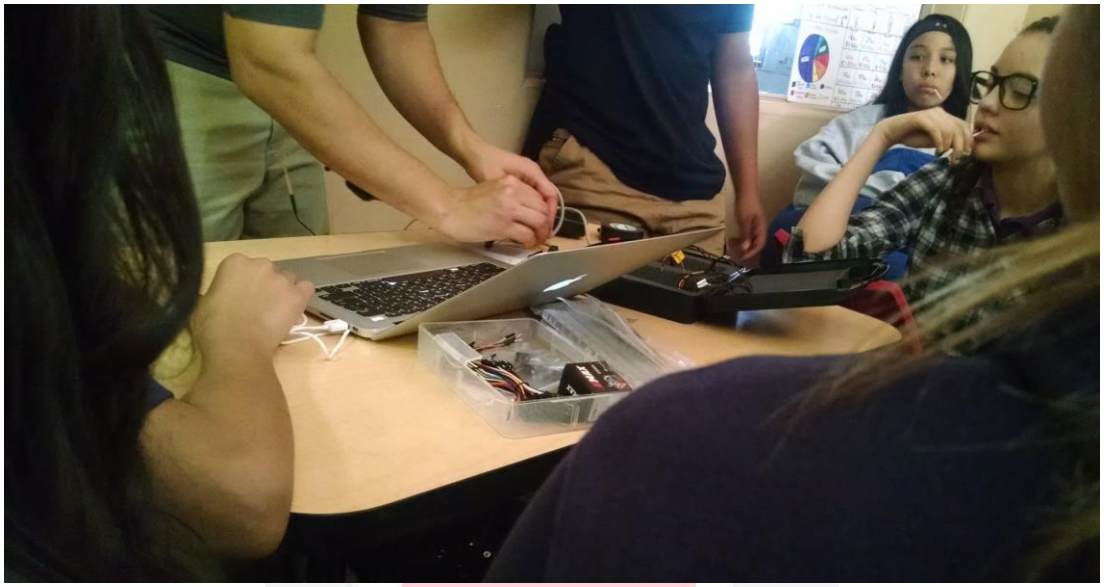
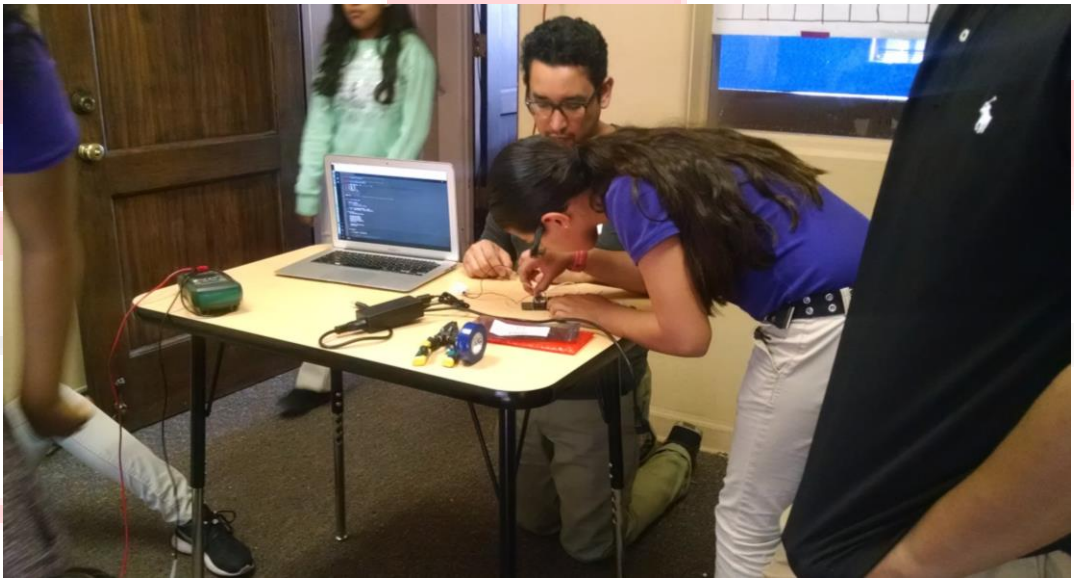


3. Break

4. (60 min) **Set up temp/ humidity sensor and connect humidifier to relay**
    a. Humidifier will be controlled by IoT Photon via a relay and sensor
    b. Temp and humidity tracked via thingspeak





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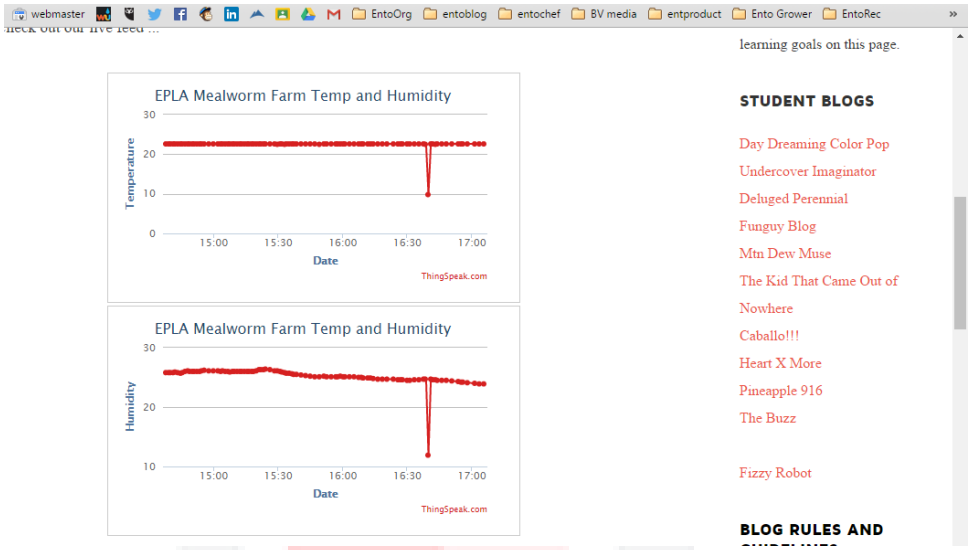
## HOMEWORK:

1. Embed [thingspeak] live feed for temperature and humidity to your blog using an html iframe, describing feed source and significance.
2. 





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## FUTURE LESSON & ACTIVITY IDEAS

1. Attach and program fan and heater to relay
2. Remove adult beetles 1.5 weeks after no more emerge as pupae to prevent cannibalism
3. Use adult beetles for chicken feed
4. Transfer F1 larvae to grow bags when they're large enough to not fall through mesh
5. Deeper farming question scavenger hunt on the open bug farm forum
6. Yield and feed conversion ratio calculations upon F1 harvest
7. Community cooking demo with F1 harvest
8. Write Instructable as a class for mealworm farm





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