Activity: Kicking off the Composting Design Experiment

Contributed by: Kansas State University, Computing and Information Systems Department, National Science Foundation GK12 INSIGHT Program

Prepared for http://www.teachengineering.org/

*Subject Area(s)
Life Science
Biology
Science and Technology
Computer Science

*Associated Unit
Dig it! Composting Analysis with Temperature Sensors

*Associated Lessons
Compost Design
Creepy Crawlers - Worm Biology
Gathering Data

*Associated Activities
Hands On Activity: How Fast Can A Carrot Rot?
Designing Composting Alternatives
Evaluating Composting Alternatives
Hands on Worms

***Grade:** 6 (5-7)

Time Required
45 minutes

Group Size
Approximately 20 (entire class works together). Portions involve groups of two for "pair and share" discussions.

Cost Per Group
Three remote temperature displays @ ~$25
Three compost temperature loggers @ ~$100
Assumes access to a computer and the data logging software (comes with loggers)

Total ~$375

*Summary

This sustainability activity focuses on designing and kicking off the experiment to determine which composting design or designs offer the best composting environment. Students will learn about instrumentation, measurements, experimental design and controls, and will gather data in order to evaluate several alternative composting designs and determine which designs are most effective. Students will get to work with temperature sensors, data loggers, and measuring devices during the analysis and conduct a variety of engineering-related analysis skills such as data gathering, filtering and graphical analysis. Issues associated with data quality and controls will be discussed along with the hands on activities.

*Engineering Connection

Engineers help address sustainability issues and work in a variety of ways to support the three Rs+C: Reduce, Reuse, Recycle and Composting. Engineers are crucial to designing waste reduction and waste management systems that are as effective, efficient, and cost-effective as possible. Comprehensive waste management systems are likely to include composting as a way to take our biodegradable kitchen and plant waste and turn it into useful products such as natural fertilizer. This activity focuses on the issues and tools associated with gathering data for a long-term experiment and preparing to use the information appropriately to evaluate experimental results.

*Engineering Category

1. Relating science and/or math concepts to engineering
2. Engineering analysis or partial design
3. Engineering design process

***Keywords:** sustainability, recycle, reuse, compost, compost bins, science, ecology, environment, trash, waste management, waste reduction, biodegrade, worms.

*Educational Standards

Shawnee School District Grade 6 (2010) from Kansas Science Standards -

- Objective 4006.01 - Identify a problem statement that can be answered through science investigation.
- Objective 4006.02 - Design and conduct investigations safely using appropriate tools, mathematics, technology, and techniques to gather, analyze and interpret data.
- Objective 4006.03 - Identify relationships between evidence and logical

conclusions.

- Objective 4006.08 - Understand that internal and/or environmental conditions affect an organism’s behavior and/or response in order to maintain and regulate stable internal conditions to survive in a continually changing environment.
- Objective 4006.15 - Recognize that all populations living together (biotic resources) and the physical factors (abiotic factors) with which they interact compose an ecosystem.
- Objective 4006.35 - Trace the energy flow from the sun (source of radiant energy) to producers (via photosynthesis – chemical energy) to consumers and decomposers in food webs.

Prerequisite Knowledge

- (none)

*Learning Objectives

After this activity, students should be able to:

- Identify a problem statement that can be answered through science investigation.
- Describe and select appropriate temperature sensor devices.
- Consider the difficulties of experimental design and maintaining controls.
- Practice graphing and working with temperature data.
- Understand data gathering on a broader scale.
- Creating a problem statement for investigation "which design produces the best temperature profile" (with a definition of "best").
- Prepare to gather data using appropriate tools, technologies, and techniques.
- Understand how the process we're learning on a small scale is being conducted by scientists all over the world.
- Understand that the source of the temperatures measured is the sun's radiant energy both at the time of measuring - and before by being stored in producers as chemical energy, to consumers, decomposers.

*Materials List

The overall class needs:

- 3 compost bins of different designs (can be done with as few as 2)
- 3 remote data loggers each with a temperature probe (could use temperature + humidity)
- 3 remote temperature displays (so you can view temperatures from the classroom while the experiment is running)
- Data logger software (included free with recommended loggers)

Each group needs:

- Pencil and paper for manual logging exercises.

*Introduction / Motivation

This activity provides the students with a chance to compare the difficulties and challenges of "old-fashioned" manual recording with automatic data recording with sensors and loggers. Students explore factors affecting their data and work through the process of selecting and configuring appropriate equipment.

Vocabulary / Definitions

Word	**Definition**
Compost	Both the organic material that has been decomposed and recycled and the act of creating the system to intentionally recycle materials and create useful soil.
Data Logger	A device for recording information over time.

*Procedure

Background

Before the Activity

- Purchase loggers. Install battery.
- Download and install Lascar's EL-WIN-USB software (current URL is http://www.lascarelectronics.com/download-instructions.php?id=101)
- If using multiple loggers, label each A,B,C etc with a permanent marker.
- Get ziplock baggies (one per logger) if environment will be wet or messy.

With the Students

- **Engage** (5 minutes) - We're going to take a look at applying science to determine which of our composting designs are the most effective. From what you've learned of composting, what factors help make a compost bin "effective"? [Size, shape, contents, mixing, ambient temperature, internal temperature, number and habit for decomposers, others]. Can we design an experiment to objectively measure some of these factors? [Temperature, humidity,pH] Can we measure temperature? Has anyone measured temperature before? What device or tool did you use? If we want to measure the temperature in the middle of our compost bins over a month, how would that work? [the temperature is over/out there & inside - and we are generally here in the classroom]. So we might want something a little bit different. We'll look at several sensors and tools we can use to get the information we need in our lesson today. Temperature is an indication of the level of HEAT and heat follows predictable patterns just like gravity (just like Newton's laws of motion, scientists ave discovered several laws of "thermodynamics" so when we add a specific amount of heat

to a pot of water, scientists can predict *exactly* how the temperature will change by using these laws. But - what's the temperature in this room? Is it the same everywhere? If we know the temperature today, can we predict exactly what the temperature will be in here tomorrow? We're going to study a small environment. But scientists are using some of these same tools and techniques to study a much larger environment. Which environment is that? [ours, the earth] Why? [we want to know what the weather will be]
Video - "NASA's Taking the Earth's Temperature" (4 min)

- **Explore** (5 minutes) - Hands on. Three groups with three simulated compost bins. Each group will monitor a simulated compost bin.
  - Warm up three "bins".
  - Hand out the display device and associated remote sensor (inside & "outside" temperatures)
  - Have each group put the remote sensor in a bag and put it in their "bin".
  - Can you see your compost temperature?
  - Explain channels and how to verify the channel is correct. Verify.
- Get out a piece of paper and a pencil. Record your inside and outside temperatures. What if this was all we had? Would it be nice if something could do that for us? Explore the logging devices. Instructor illustrate onscreen the process of beginning a logger. Have the class make the decisions about what to enter together. Hint: Start / All Programs / EasyLog USB. From the menu, select Options / Set up and Start. Name the logger something like "LoggerA", select type as K-Type, and select units. Set the sample rate depending on your experiment length and requirements (5 min (3.5 Mths)). Click Next. Next. Finish. OK. and disconnect the logger.

- **Explain** (5 minutes) - While the data is being gathered, explain the software for pair and share about ideas for meteorology. What kinds of things do we measure? Is it hard to predict the weather? How many weather stations would we want? Is it possible you could get a bad reading? How do scientists decide on an "average temperature"? How are these issues similar to what weather forecasters do every day? Describe the butterfly effect.

- **Elaborate** (10 minutes) - Learn more about the tools and technologies by learning more about specific temperature sensors and data loggers.
  - Where should we place our receivers? Careful to make sure the correct channel is being displayed.

- Experiment (10 minutes) - Prepare our equipment and head outside to kick off the experiment.
  - Bag each set of monitors.
  - Verify associated receiver is set to the right channel.
  - One group at a time (display on screen):
    - Select a compost bin.
    - Plug logger in to USB.
    - Set up logging - name with letter and your design.
    - Place both devices in the paper bag.
    - Record which compost bin your set of devices (A, B, or C) will be associated with.
  - When all groups are initialized, we'll head outside to deposit them.

- **Evaluate** (5 minutes) - wrap up - review what we've learned. When you bring in your sensors, be sure to (1) plug in to the USB and (2) use the software to download the data. You can start and stop the experiments as often as you like. **Bonus**: Being able to read and analyze a lot of information is very important. There's a very interesting application of soemthing looks a lot like our temperature graphs. We can use our ability to do this to help find planets. Seriously. Scientists take measurements of how bright various stars are. It's messy [show a chart]. Now what if a planet went in front of the star? [It will cast a slight shadow] What would happen to the intensity of the light? [it will drop]. Volunteers can help look for these at

Safety Issues
None.

Troubleshooting Tips

Investigating Questions

Assessment
To evaluate the effectiveness of this unit, a pre-activity assessment is available that can be administered prior to beginning the activity and a post-test is available that can be administered after students have completed the activity.

Attachments
Pre-Activity Quiz
Pre-Activity Quiz with Answers
Post-Activity Quiz
Post-Activity Quiz with Answers

Additional Multi-Media Support
NASA video: Taking the Earth's temperature http://www.youtube.com/watch?v=JRayIgKubIg&feature=related
NASA video: Temperature Puzzle http://climate.nasa.gov/ClimateReel/TemperaturePuzzle640360/
Rap http://www.youtube.com/watch?v=7Y3mfAGVn1c&feature=related
Bill Nye on Heat http://www.youtube.com/watch?v=f1eAOygDP5s&feature=related
Bill Nye "Every Measurement you make" http://www.youtube.com/watch?v=ZMpgKo4AKb0
Ending: Episode 4: Decomposers (The Unseen World) http://www.youtube.com/watch?v=Z6V0a_7N1Mw
Energy Transfer in Ecosystems: http://www.youtube.com/watch?v=hBvTDyIIxMA&feature=related

References

Other

Redirect URL

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Image from Wikipedia: https://en.wikipedia.org/wiki/File:Green_compost_bin.JPG