Critter Curators

Grade Level: 4

Key Concepts
Habitats * Life Processes * Interrelationships among Living Organisms
Earthworm Biology

Mathematics Strands
Measurement * Computation and Estimation * Probability and Statistics

Skills
Observing * Measuring * Analyzing Data
Drawing Conclusions * Communicating

Nature of Science
Scientific Inquiry * Problem-Based Learning * Real-Life Applications * Collaboration

Science	**Problem-based learning investigation into the necessary components of an earthworm habitat**
Technology	**Use a digital camera * Web-based research * Use measurement tools**
Engineering	**Design a habitat**
Mathematics	**Estimate and measure length * Graphing**

Time:
Three - Five 45 minute sessions

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Overview

Critter Curators is a problem-based learning (PBL) lesson that introduces fourth graders to the hands-on study of living systems. In PBL, students act as scientists to solve a problem in a real-world context. They do so by collecting and analyzing data, and by considering practical parameters or constraints, in order to generate solutions to the problem. In this lesson, the students play the role of museum curator and are given the task of creating an earthworm habitat exhibit for their classroom "museum".

In order to design the habitat, students must investigate the connections among an earthworm's needs, habitat, and niche. The lesson is designed with structured inquiry components in which students pursue knowledge about the earthworm's preferences and needs. In the inquiry portion of the lesson, the central investigation question is: "What are the necessary components of a habitat for an earthworm?" To understand the earthworm's needs and preferences, students conduct inquiries to make reasonable considerations for the museum habitat. By using scientific process skills to make observations and inferences, collect and analyze data, and communicate their findings, the students carry out investigations which ask appropriate questions, such as "Do earthworms prefer light or dark?" and "Do earthworms prefer hot or cold?."

Students finally put their findings from the investigations together to design and construct a museum display that showcases the earthworms in their habitat. The lesson emphasizes collaboration and communication.

Objectives

Know

- Organisms can survive in environments that support their basic needs: water, a food source, shelter, and space to move.
- An earthworm's habitat is a cool, dark, and moist soil environment.
- An earthworm's niche includes: aerating and fertilizing soil; decomposing waste; and being food for birds, snakes, and beetles.
- A museum curator helps to design exhibits to educate the public about specific topics.

Understand

- Scientific inquiry involves participating in processes such as questioning, experimenting, collecting data, analyzing data, drawing conclusions, and sharing results.
- Relationships exist between an organism's needs and its habitat.
- Relationships among populations of living organisms and between living organisms and non-living parts of their environment exist in an ecosystem.
- The size of an animal is an important determinant of the space it needs.
- Technology can be used to aid in communication and sharing results with others.

Do

- Conduct investigations to determine the basic needs of an earthworm.
- Observe and describe the characteristics of an earthworm.
- Investigate how earthworms interact with non-living components of their environment, including soil and rocks.
- Estimate and measure the length of an earthworm in U.S. Customary and metric units.
- Use a thermometer to measure temperature.
- Design a suitable earthworm habitat based on observations and results from investigations.
- Use a digital camera to record observational data.
- Communicate results, conclusions, and other newly-learned information about earthworms.

Standards

Virginia Standards

Science 4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which

a) distinctions are made among observations, conclusions, inferences, and predictions;
c) appropriate measurement instruments are chosen;
e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources;
i) data are collected, recorded, analyzed, and displayed using bar and basic line graphs.
k) data are communicated with simple graphs, pictures, written statements, and numbers.

Science 4.5 The student will investigate and understand how animals, including humans, in an ecosystem interact with one another and with nonliving components in the ecosystem. Key concepts include:

d) habitats and niches.

Mathematics 4.7a The student will estimate and measure length, and describe the result in both metric and U.S. Customary units.

Computer/Technology 3-5.8 The student will use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

National Standards

SCIENCE AS INQUIRY, Content Standard A (grades K-4)
As a result of activities in grades K-4, all students should develop

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

LIFE SCIENCE, Content Standard C (grades K-4)
As a result of activities in grades K-4, all students should develop understanding of

- The characteristics of organisms
- Organisms and environments

Mathematics: Measurement Standard for Grades 3-5
In grades 3-5 all students should

- understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute;
- understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems

Mathematics: Data Analysis and Probability Standard for Grades 3-5
In grades 3-5 all students should

- collect data using observations, surveys, and experiments.

Preparation

For Session One, "Meet Your Worm"

For each student:

- ☐ 1 earthworm
- ☐ 1 8 oz clear plastic cup to contain the worm
- ☐ 1 pipe cleaner (wire ends rolled up)
- ☐ 1 hand lens
- ☐ 2 rulers (in cm) (or can use 2 rulers per two students)
- ☐ 2 paper towels
- ☐ Access to spray bottles filled with water
- ☐ Access to container of wipes
- ☐ Plastic spoons (for those afraid to touch worms)
- ☐ Chart paper
- ☐ 1 Observation Card (*optional*)
- ☐ 1 "Meet Your Worm" investigation sheet

Earthworms dug from outside tend to be fragile and die early. Instead, purchase in advance. Order from Carolina Biological or find "nightcrawlers" in a store such as Wal-mart in the Sporting Goods Dept.

For Session Two, Investigations

For the class:

- ☐ Digital camera
- ☐ Computers with Internet access
- ☐ Extra worms
- ☐ Extra 8 oz clear plastic cups
- ☐ Extra paper towels
- ☐ Spray bottles filled with water

For each group:

- ☐ At least 4 worms
- ☐ 2 8 oz clear plastic cups
- ☐ 1 clear plastic shoe box
- ☐ 1 roll of paper towels
- ☐ 2 spray bottles filled with water
- ☐ 1 ruler (in cm)
- ☐ 2 hand lenses (1 per 2 students)
- ☐ ¼ lb sand
- ☐ ¼ lb red clay soil
- ☐ ¼ lb top soil
- ☐ 1 sheet of black construction paper or cardboard
- ☐ 1 flashlight

- [ ] 1 heating pad or instant heat packs
- [ ] 1 lunchbox size frozen cold pack or bag of ice
- [ ] 1 timer or stopwatch
- [ ] 1 pack of sticky notes, with a different color for each group
- [ ] Copies of “Critter Curators: Earthworm Investigation #1-4” (1 of each investigation sheet for each student in the group)
- [ ] 1 container of wipes
- [ ] 1 permanent marker

Heating pads and ice packs can be purchased in a pharmacy department. Instant heat packs are available in sporting goods departments (as “hand warmers”).

For Exhibits

- [ ] A variety of container choices (plastic shoebox, jars, etc) in which to make exhibits (students may bring these from home)
- [ ] Earthworms (number to be determined by students)
- [ ] ¼ lb sand
- [ ] ¼ red clay soil
- [ ] ¼ lb top soil
- [ ] Food for the worms (dead leaves, twigs, etc)
- [ ] Spray bottles filled with water
- [ ] Paper towels
- [ ] Heat and cold sources
- [ ] Materials to make posters for the exhibits, such as markers, crayons, poster board, and digital photos.

Purchase more worms, or use any left from experiments.

Getting Ready

Before the day of the activity

1. Before Session One, duplicate and administer the *Pre-Assessment* to the class.
   a. For question 5, choose an object to pass around the class that will elicit careful observation (ex: a rubber insect or animal).
   b. For question 6, cut some pieces of yarn and have tape available for the students.
   c. Note any students who have difficulty describing habitat or recording observations. Consider using the *Observation Task Cards,* provided in the appendix, to scaffold and organize observations.

2. Organize class into 4 groups based on pre-assessment results:
   a. Note student attitudes toward worms (question 3). Group them so that a student who dislikes worms is placed in a group with others who are comfortable with them.
   b. Note student facility with estimation and measurement (question 6) and group them so that all members of a group have equivalent measuring skills. This way, all members can be challenged or helped along appropriately.

3. Ensure that you have access to the video of the curator-led tour of the exhibit found at http://forces.si.edu/soils/.

4. Using the *Digital Camera Checklist* (provided), assess student readiness to operate a digital camera.

5. Read *Diary of a Worm* to students (optional).

Diary of a Worm*, by Doreen Cronin, uses kid-friendly cartoons and humor to discuss earthworms. Reading it to the class may help those students who are uncomfortable with worms.*

Session One: Meet Your Worm

1. **Context: Museum**
    a. Remind students of their answers to pre-assessment question 4, about experiences visiting museums.
    b. Encourage students to share their experiences with the whole class.
    c. Prompt students to consider the role of a museum curator.
    d. Show the short video clip at http://forces.si.edu/soils/ of the curator-led tour of the exhibit.
    e. Discuss what being a museum curator involves.

Write the investigation question on the board (keep it up for the whole lesson): **What components in a habitat are necessary to support life for earthworms?**

2. Read the *Problem Statement Task Card* aloud to the class: *The Children's Museum of Science is searching for teams of student curators to design a habitat exhibit on earthworms. As student curators, your job description will include close examination of the species, investigation of its needs, and careful engineering of a habitat. Student curators must keep the audience, children who will visit the museum, in mind as you plan.*

3. **Facilitate discussion,** using the following questions:
    a. As a museum curator, how would you design an exhibit about worm habitat?
    b. What do we already know about earthworms?
    c. What are some things you might need to know about earthworm habitat before designing an exhibit about earthworms? (in other words, what are some important questions about earthworm habitat that should be answered and acted on before the exhibit?)
    d. How would you go about finding out these things?

An optional Critter Curators Problem Discussion Board *is included in the Appendix to record student responses.*

4. Record any questions about earthworm habitat on chart paper or a SMARTBoard®. After the investigations, revisit these questions to see if answers to them were found.

5. **"Meet Your Worm":**
    a. Give each student a worm, housed in a clear plastic container with a damp paper towel on the bottom.
    b. Students are welcome to take the worm out of the container, but worms need to be placed on a damp paper towel.
    c. To scaffold their observations, give each student a *Critter Curators Day 1 'Meet Your Worm'* handout (provided),

and/or an *Observation Task Card* (especially useful for those uncomfortable with writing or who have difficulty with careful observation.)

Remind students to moisten their fingers before touching worms.

Provide several spray bottles of water to keep the worms moist during handling.

6. **Observation and Measurement**

    a. Before students measure their worms, ask them to estimate their length in both inches and centimeters.

    b. Model how to measure an earthworm:
        i. Place two 12-inch rulers parallel to each other, at least 1 or 2 cm apart.
        ii. Place the earthworm between the two rulers. Carefully holding one end of the earthworm in place at the end of the rulers, gently rub the earthworm to stretch it out. Then measure the worm as best as you are able in both inches and centimeters.

    c. Guide a brief class discussion of experimental error and the importance of making careful observations. If you are using *Observation Task Cards*, draw students' attention to them.

    d. Discuss comparisons of lengths measured in cm and measured in inches. Ask students for ideas on estimating cm given inches and estimating inches given cm.

As an optional challenge to advanced students, explain averaging as a method of finding the center of several data points. Take three measurements of the earthworm and model taking the average of these measurements.

7. **Clean up**: After the hands-on part of today's investigation, students will replace their worms in their containers, complete with damp paper towel or moist dirt.

8. **Formulate hypotheses:** Guide a whole-class discussion based on student observations and measurements. The central question here is: *How much room do you think the worm will need in its museum habitat? Why?*

9. **Exit Ticket**: *Based on your earthworm observations, what do you think an earthworm needs in its habitat?*

Session Two: Critter Curator Investigations

This investigation is a structured inquiry lesson. The teacher will provide the questions, the materials, and the procedures. Students will conduct the experiments by working together in groups. This lesson uses an inquiry approach in providing students with: a testable question to investigate; the opportunity to collect and analyze data; data to answer the question; and the responsibility to share and reflect on their findings with the class. During the investigation, circulate around the room to ensure that students are following the procedure carefully and to provide guidance and questions as needed to scaffold the learning.

Post investigation question on the board:
What components in a habitat are necessary to support life for earthworms?

Getting Ready

Post the questions for each of the inquiry investigations in a suitable location:
Station #1: Do earthworms prefer Moist/Dry?
Station #2: Do earthworms prefer Light/Dark?
Station #3: Do earthworms prefer Cold/Warm?
Station #4: What type of soil do earthworms prefer?

1. Set up four investigation stations well apart from each other in the classroom. Station #1 is to determine whether earthworms prefer moist or dry areas; Station #2 is to determine if earthworms prefer light or dark; Station #3 investigates if earthworms prefer cold or warm; and Station #4 investigates if earthworms prefer sandy, clay, or top soil.

    a. At each station, place a shoebox-sized plastic container.

    b. Station #2 container should be opaque. Tape the paper or cardboard in the container to divide it in half, so that little light can pass through, but not reach to the very bottom, giving the worms enough room to move between sides. Cut a hole in one wall of the container just big enough for a flashlight.

    c. Place the other materials students will need beside the containers:
        i. **All stations:** 1 roll of paper towels; 2 spray bottles filled with water.
        ii. **Station #2:** 1 flashlight; black construction paper or cardboard (cut to fit width of container)
        iii. **Station #3:** 1 bag of ice or freezer pack; 1 heating pad or instant heat; 2 thermometers
        iv. **Station #4:** 1 container each of sandy soil, clay soil, and topsoil

Consider asking the first group to visit each station to set up that station's investigation.

2. Group students based on pre-assessment data. Groups will rotate through the investigation activities in 15-20 minute intervals.

You may wish to assign each group a number (1-4) to help

3. Remind students of the investigation question: **What components in a**

habitat are necessary to support life for earthworms? Draw attention as well to the questions that are being investigated at each station.

with classroom management.

4. To each group, pass out the investigation materials that they will bring from station to station:
    a. 1 container with at least 4 earthworms
    b. 2 plastic cups with holes
    c. 1 timer or stopwatch
    d. 1 ruler
    e. 2 hand lenses

If you choose to have each group set up the first station they investigate, have the group numbers correspond to that investigation number.

5. Pass out "Critter Curators: Earthworm Investigation #1-4" sheets to the class, one of each per student.

6. Instruct students to use the permanent marker to label their plastic cups "Trial 1" and "Trial 2". Have students place a moist paper towel in the bottom of each cup.

7. Prepare the Class Data Graph:
    a. Draw a large grid on a whiteboard or white poster board. Make sure the grid is large enough to accommodate the data points, as represented by colored sticky notes.
    b. Title the plot "Earthworm Habitat Preferences."
    c. Label the X-axis "Habitat Options" and the Y-axis "Number of Worms."
    d. Label Y-axis with: 0 – 5.
    e. Label X-axis with: Moist; Dry; Light; Dark; Cold; Warm; Soil; Sand; Clay.

Alternatively, leave the axes unlabeled and after the investigation, elicit student input and guide the class to label the axes appropriately.

The Investigations

1. **Introduce the investigations**:
    a. Explain that the groups will be figuring out some of the answers to the questions about habitat from the previous session. They will learn whether worms prefer moist or dry areas, light or dark conditions, cold or warm conditions, and what type of soil they like best.
    b. If you have not fully prepared the stations, students will prepare each station, following the "Procedure" steps in *Critter Curators: Earthworm Investigation* sheets.
    c. Explain that because of experimental variance and individual differences among earthworms, it's important to have multiple trials for each condition. Tell students that they will be doing two trials for each station, with two worms per trial.
        i. For each station, students will take 4 earthworms out of

their worm box and put 2 worms in the plastic cup labeled "Trial 1" and 2 worms in the plastic cup labeled "Trial 2."

ii. For the first trial, students will place the 2 worms from "Trial 1" cup into the station container, observe them for 5 minutes, and record their observations on the "Earthworm Investigation" sheet for that station. The worms from trial 1 will be put back into the Trial 1 plastic cup.

iii. For the second trial, students will put the "Trial 2" worms into the station container. Again, the worms will be observed for 5 minutes and observations recorded on the "Earthworm Investigation" sheet for the station.

d. Recording observations: Go over the "Observations" section on the *Critter Curators: Earthworm Investigation* sheets. Explain that students should write how many (0-2) worms in each trial chose which option. Students should add the numbers of the two trials to get an experimental total. This number (0-4) for each station will be the data each group will contribute to the Class Data Graph.

2. Once it is clear that everyone understands the investigation purpose and procedure, have students begin the investigation.

3. Groups will rotate through all 4 stations and record their findings on the *Critter Curators: Earthworm Investigation* sheets.

4. As the groups do the investigation, circulate through the classroom, offering guidance and advice when needed. Make notes about the students' experimental technique and accuracy.

Sharing Results

Depending on how long the investigation itself took, this "Sharing Results" component may need to be moved to the following day.

1. Once all groups have completed their investigations, draw their attention to the "Observations" section of their *Critter Curators: Earthworm Investigation* sheets.

2. Show the class the grid you have prepared for the Class Data Graph.

3. Guide discussion of the x- and y-axis labels, or, if you have left them unlabeled, ask students how you might label them and guide discussion to an appropriate conclusion (Y: "Number of Worms"; X: "Habitat Options"; or similar).

4. Invite each group to choose a representative to record their data on

If time and student preparedness permits, consider introducing the concepts of independent (the various habitat conditions) and dependent (number of worms) variables. Distinguish between them by asking what the students manipulated (moisture; temperature; soil

the class plot, using their colored sticky notes.
    a. If more than one group has the same number of worms in an option (ex: two worms chose dark over light in two different groups), have the second group affix their sticky note directly on top of the first one. Sticky notes should only be at whole number indicators.

type; amount of light) and what changed based on those manipulations (number of worms).

5. Once all the groups have placed their sticky notes on the graph, have the class determine a grand total for each condition.

6. As a class, discuss and analyze the results. Track any obvious trends, and invite students to draw conclusions about worm preferences.

7. Note any outliers, or worms that prefer the opposite condition to most of the others. For example, although results normally show a majority of worms preferring cold over warm, there may be one or two that prefer warm. Elicit student ideas about this: Why would this happen? Was something different in the way one group recorded temperature? How would this affect interpretation of the totals (and/or centers)?

8. If there's time, have students construct their own bar graphs based on the Class Data Graph. They will draw 4 bar graphs, one for each variable, with each bar representing the center or the sum of the class worm number results. (example: for soil type, there will be 3 bars, one for each soil type, and the bar heights will be based on either the total number of worms found in each soil type or the average number in each soil type).

Although this is a 4th grade lesson and averaging is not introduced until 5th grade, this chart design is well suited to an introduction to the concept of centering. Once all groups have affixed their data points to the grid, ask students to estimate the "center" of the points for each condition. While they are marking their guesses, quickly calculate the average number of worms for each condition. Tell students that you have found the mathematical center, and compare the mathematical average with their estimates. Discuss centering as a more reliable and informative number than the original group of points. Compare finding the center with finding the sum in terms of reliability and information.

Drawing Conclusions

1. Bring out the page of chart paper or SMARTBoard® from Session One with the students' questions about habitat written on it.

2. Discuss the questions and whether the class has discovered answers to any of these questions.

3. For any questions that have not been answered, elicit ideas for how to answer them.

As an optional extension, as appropriate, consider investigating additional questions in a later class, doing as a take-home activity, or writing letters to communicate with experts.

Preparing for the Exhibit

1. Tell the class that tomorrow is the day to design the earthworm habitat exhibit. The class will be divided into the same groups as for the investigation.

2. Encourage students to use what they have learned, through their own observations as well as through the Class Data Graph of shared results, to design their habitat.

3. Hand out one *Exhibit Planning Sheet* to each student.

4. If time permits, give the groups time to discuss their exhibits, starting with what container to choose and why. This way, if they need to bring something from home, they can. Remind students of their hypotheses about habitat space from Session One.

Allowing class time at this point for a discussion about containers gives students the opportunity to bring containers from home.

5. If there's time, students will do the Internet research into earthworms. If not, assign this for homework. The *Critter Curators Research* handout is designed to scaffold Internet research around the question of how to choose a container for the exhibit.
    a. Each student in a group will choose one of the websites on the handout, so that all 4 sites are covered. If there are more than 4 students in the group, they can divide the websites further: for example, have one student research the first 4 topics in "The Adventures of Herman the Worm" and one student research the next 5.

6. **Exit Ticket**: *Based on what you observed and the data you collected, what components need to be present to create a suitable habitat for earthworms?*

Session Three: Earthworm Exhibits

Getting Ready

Students may bring supplies from home, but you will need to have additional supplies on hand.

1. Have available a variety of containers.

2. Set up a "habitat center" in the classroom for students to create their worm habitats. See the Materials list for "Exhibit," above.

3. Prepare index cards to hand out, 1 for each student, as they enter the room. Write on them: *How did you use your observations and data from the investigation to select your container?*

Cover the floor of the "habitat center" with newspaper or some other covering, as habitat construction can be messy.

Habitat Creation

1. As the students enter the room, give them each a prepared card with the container question.

2. Invite groups to discuss how they selected their containers, and then have each group share with the whole class.

3. Call student groups to the "habitat center" one at a time, and invite them to choose materials necessary to the earthworm and put together their habitats. Ask the students to consider how and why their habitat will be a good one for their earthworm.

4. Have groups who are not working at the "habitat center" create posters, mobiles, or a product of their choice to support their exhibit. Remind them of their roles as curators, and encourage them to make products that:
    a. are attractive and appealing to "museum visitors";
    b. include information about earthworms; and
    c. answer the questions:
        - *What components in a habitat are necessary to support life for earthworms?*
        - *Based on your observations and research, what are some basic characteristics of earthworms?*

5. Demonstrate how to use a digital camera and then have the students photograph their exhibit. Use the *Digital Camera Checklist* from the Pre-Assessment to gauge students' skill in operating the camera.

Presenting and sharing exhibits

1. Students will present their habitat exhibits to the rest of the class. Encourage them to explain how they used data from the investigation to design the habitat.

2. Consider the following questions to help facilitate the presentations:
   - How would your habitat need to be modified if it were placed in an actual museum?
   - How are the needs of the earthworm being met (or not met) in your constructed habitat?
   - How did doing the investigation help you create your exhibit?
   - How did using the information from the websites help you determine the necessary components for your exhibit?
   - Why was it important for us to do multiple trials when we were conducting the earthworm investigation?

3. Generate discussion about earthworm niche and the interdependence of earthworms and humans (and other organisms). This discussion can be a closure activity or it can lead directly into the next unit of study.

Consider keeping the habitats in the classroom and observing how the worms do over the next few days – how long they survive, how the habitat alters, etc.

If the earthworms are not native Lumbricus terrestris*, then destroy the worms by placing in the freezer for two weeks before throwing in the trash.*

Going Further

Classroom Museum

Transform your classroom into an earthworm museum and invite other classes to view the exhibits and learn about earthworms and their habitats.

Worm Rhymes

Write poems about worms.

Transforming habitat into ecosystem

This lesson provides a framework for exploring earthworm's niches and the larger concept of interdependence and energy flow among living things. As an extension, students will introduce additional organisms into the habitat exhibit, transforming it into a terrarium. Challenge students to research which organisms would be appropriate to add and to predict what the effects of their introduction might be before introducing them. Students will continue to collect and analyze data to deepen their understanding of living systems.

Conservation Focus

Students will introduce additional non-living things into the terrarium or habitat. Challenge them to research local byproducts of industry or other human activity, and then introduce these substances (if safe for people). Students will experiment with different amounts or concentrations of substances or with different placement. They will record their observations of the effects and represent these data on a graph.

Continuous Variables

The habitat components (independent variables) that the students have manipulated in the lesson are discrete variables (or binary choices); for example, light OR dark, hot OR cold. As a means of allowing the students to participate in the investigation design, making the inquiry more guided rather than structured, challenge the students to design an experiment to test a broader question. For example: What is the worm's temperature preference? Instead of hot OR cold, the student can create a more nuanced temperature testing method. Similarly, students might investigate the worms' preference for light by designing a method to vary the light across a wider spectrum (dark > dim light > medium light > bright light). Students will be supported in their

method design by using the investigation procedure from earlier as a model. Depending on the method the students design, they may be able to graph the results as a line graph. Surprising results can be discussed by the class. For example: although worms generally prefer moist to dry soil, it's possible that they do not like very wet soil.

Real "Real-world" problems

Take the investigation into the field by inviting students to count the number of earthworms in various sectors of a school field. Challenge them to look for any systematic differences in earthworm number/size/other attribute of their choice that varies with differences in habitat.

Composting

Invite students to do some more Internet research (using the same websites) on worm composting, or vermiculture. Students will then create a worm compost bin for the class. As a further extension, they will plant seeds in soil produced by the worms and other types of soil, then compare plant growth.

Literature Connections

Online resources for the Internet research activity, during Session Two or as homework before habitat construction.

1. Wolford, R., Stack, G., Scherer, J., Hawley, M., & Tidrick, C. (2012). **The adventures of Herman the worm.** Retrieved June 11, 2012 from http://urbanext.illinois.edu/worms/index.cfm
   Earthworm information, presented in an engaging, kid-friendly way. Includes earthworm history, classification, anatomy, food, uses, facts, games, links, and a guide to setting up a worm composting bin.

2. **Worm world.** (2000). In *The Yuckiest Site on the Internet*. Retrieved June 11, 2012 from Discovery Kids site http://yucky.discovery.com/flash/worm/
   Earthworm information, presenting in fun and engaging way. Detailed information about anatomy, composting, etc.

3. **Earthworms.** (2012). In *Animals Creature Features*. Retrieved June 11, 2012 from National Geographic Kids site http://kids.nationalgeographic.com/kids/animals/creaturefeature/earthworms/
   Includes brief earthworm facts and many earthworm pictures.

4. **Earthworms and their relatives.** (2012). In *BioKIDS Critter Catalog*. Retrieved June 11, 2012 from University of Michigan BioKIDS site http://www.biokids.umich.edu/critters/Oligochaeta/
   Detailed earthworm information, pictures, specimens, and classification.

Additional resources:

1. **WildKratts videos.** (2010). In *PBSKids Go!* site http://pbskids.org/wildkratts/videos/
   Scroll to bottom to choose "Worm Alert!" and "Worm Slime!" These are engaging cartoon videos about worms, which ask questions like, "Why do earthworms come out when it rains?"

2. Cronin, D. (2003). ***Diary of a worm*.** HarperCollins.
   Funny and engaging introduction to basic worm behavior and characteristics. Useful as a springboard to discuss habitat and needs of an earthworm. Also useful in helping students who are uncomfortable with worms to feel more favorably toward them.

Behind the Scenes

This lesson focuses on habitats, particularly of earthworms. A habitat is defined as the place or kind of place in which an organism naturally lives. An organism's habitat provides it with the things it needs to live: food, water, shelter, and space. The size of the habitat depends on the organism's needs.

The term "habitat" is often confused with "niche" as well as other terms describing living systems. Teachers should pay special attention to the correct usage of these terms to prevent confusion.

- Niche: the role an organism plays in its habitat.
- Population: several individual organisms of the *same* species in an area.
- Community: populations interacting with one another in an environment.
- Ecosystem: the populations and the nonliving components in an environment that interact with each other.

Earthworms are invertebrate animals, specifically of the phylum Annelida. Earthworms, as the name clearly implies, live on land, as opposed to other annelids that mostly live in water habitats. There are over 4,400 different species of earthworms, which can be grouped into three basic categories based loosely upon the depth of soil in which they can be found.

An earthworm's habitat is cool, moist, and dark – as would be found underground. Soil provides earthworms with water shelter, space to move, and food. Earthworms feed on soil nutrients and decayed organic material.

An earthworm's niche is as a decomposer of organic material in the terrestrial food web. They help to aerate soil as they burrow through, help to make soil less dense and compact, and help to distribute nutrients and minerals through soils.

The true earthworm, *Lumbricus terrestris*, is native to North America and can be ordered from Carolina Biological. Other 'earthworms', especially those commonly used as fishing bait like nightcrawlers, are not native to North America and should be disposed of by freezing for two weeks to kill them before disposing in the trash.

There are many interesting facts about earthworms that you can use to capture students attention. For example, earthworms have five hearts. They lack lungs or other specialized breathing organs; rather, the exchange of gases occurs through the body surface. Earthworms have both male and female reproductive organs.They lay eggs in the soil that hatch after about 3 weeks, producing from 2 to 20 baby worms.

Resources listed under the Literature Connections section contain other interesting facts about earthworms!

Resources for teachers

1. (2004). Earthworm encounters. *Life Science Virginia Grade 5.* AIMS Education Foundation. Fresno, CA.

2. Davis, V. (2012). Habitat of earthworms. Retrieved May 31, 2012 at: http://www.ehow.com/about_5434811_habitat-earthworms.html
   Brief introduction to earthworms and their habitat. Includes useful links.

3. Martin, J. P., Black, J. H., & Hawthorne, R. M. (2012). Earthworm biology. (Publication #CIR455 of the University of Florida IFAS Extension; originally published as Leaflet 2828 for the Division of Agricultural Sciences at the University of California, July 1976). Retrieved June 11, 2012 at: http://edis.ifas.ufl.edu/in047
   Earthworm taxonomy and biology, with focus on agricultural/commercial applications.

4. Holdsworth, A. R., Frelich, L. E. & Reich, P. B. (2007). Regional extent of an ecosystem engineer: Earthworm invasion in northern hardwood forests. *Ecological Applications, 17*, 1666-1677.
   Scholarly article on the extent and pattern of earthworm invasion in Minnesota and Wisconsin national forests. Provides interesting background on earthworms as invasive species.

5. Create a graph. *Kids' Zone: Learning with NCES*. Retrieved May 31, 2012 at http://nces.ed.gov/nceskids/createagraph/default.aspx?ID=986288823edd45af8f6fa036618cd6e6
   Interactive graphing tool.

6. Llewellyn, D. J. (2007). *Inquire within: Implementing inquiry-based science standards in grades 3-8* (2nd ed). Thousand Oaks, CA: Corwin Press.
   Guide on how to implement inquiry in the science classroom. Includes case studies, lesson plans, and resources.

Lesson Sequence

Getting Ready:

1. Before Session One, duplicate and administer the *Pre-Assessment* to the class.
   - Note any students who have difficulty describing habitat or recording observations.
   - Determine groups based on pre-assessment.
2. Using the *Digital Camera Checklist*, assess student readiness to operate a digital camera.
3. Read *Diary of a Worm* to students (optional).

Session One: Meet Your Worm

1. Ask students if they have been to a museum. Engage in a brief discussion of museum exhibits.
2. Define museum curator (show video clip at http://forces.si.edu/soils/).
3. Present problem: *What does an earthworm need in its habitat?*
4. "Meet Your Worm" activity.
5. As a class, discuss findings.
6. Exit Ticket: *Based on earthworm observations, what do you think an earthworm needs in its habitat?*

Session Two: Earthworm Investigations

1. Student investigations.
2. Students graph results (with guidance if necessary).
3. Discuss data and conclusions.
4. Exit Ticket: *Based on what you observed and the data you collected, what components need to be present to create a suitable habitat for earthworms?*
5. (*optional or as homework*) Internet research on earthworms, using the *Worm Research Sheet*.

Session Three: Habitat Design

1. Have students design habitats, based on the previous two days' observations and data.
2. Have students photograph habitats and their construction using a digital camera.
3. Reflect on investigation as a class.

Assessment

Objectives

The overall learning objective of this lesson plan is for students to understand the necessary non-living components of earthworms' habitat. By investigating earthworms, they will become familiar with components of the habitat that are necessary for earthworm survival. Learning goals also include developing skills such as measuring, making careful observations, and graphing; understanding concepts that lay the groundwork for variance; and practice with science processes through investigation (trials, variables, etc) that lead to a deeper understanding of the nature of science.

Pre-Assessment

1. Administer the *Critter Curators Pre-Assessment* several days before implementing the lesson. Use the *Pre-assessment scoring guide* to assist in your evaluation of student responses:

    a. Use pre-assessment results to group students:
        i. Group students who don't like worms with those who do, based on answers to question 3 ("How do you feel about working with worms?"). Use question 3 results as well to decide whether to read *Diary of a Worm* to the class. *Diary of a Worm* may help some students to have a more positive attitude toward worms.
        ii. Group students so that all members of a group are at roughly the same level of facility with measurement, using answers to question 6 (Estimate and measure the length of a piece of string in inches and in centimeters). This allows you to more easily help the groups who have trouble with measurement.

    b. Use answers to question 4 to guide the discussion of the curator's role on Session One.

    c. Use answers to question 5 to assess students' ability to make careful observations. Especially for those students who had difficulty with this, circulate around the room and scaffold their earthworm observation. The *Observation Task Cards* guide and organize careful observation. Consider passing out *Observation Task Cards* to those who have trouble with this, or to the whole class.

2. Administer the *Digital Camera Checklist* to assess student readiness to operate a digital camera. For those students who had trouble based on checklist results, either conduct a brief "photography" remedial lesson before the actual habitat construction, or be sure to help them during the habitat presentations.

Formative Assessment

The formative assessments gauge student progress in learning goals related to the content and nature of science and inquiry. Formative assessments include the pre-assessments (see above); student responses to the exit cards; teacher observations during the investigation; and student data collection and graphing.

1. **Exit cards** will be used to make sure that students understand the needs of an earthworm that must be met in a suitable habitat. If students struggle with this, it may be beneficial to teach a mini-lesson on habitat components before students construct their habitats.

2. **Teacher observations** during the investigation should be focused on assessing students' experimental technique and care with observations, as well as their ability to draw conclusions about habitat components based on the investigation.

3. **Student data collection and graphing** can be used as formative assessment in different ways, depending on how much emphasis the teacher wants to place on the math concepts and skills in this lesson. Assessment can be limited to monitoring student's data charts during the data collection phase to identify students who are struggling with this skill. Assessment will include the student's collaboration and contributions to the Class Data Graph. As each group contributes to the class data, probative questions can be asked to assess understanding. If formative assessment demonstrates that students are ready to progress to "centering" concepts, leading to a discussion of averages (a 5^{th} grade concept), the assessment can help the teacher to make that determination. The optional activity of having students construct their own bar graphs based on the Class Data Chart would be an excellent opportunity for summative assessment at this point in the lesson to assess mathematical conceptual understanding and skills.

Summative Assessment:

1. **Building A Structure: Critter Curators Rubric** will be used to assess student earthworm habitat exhibits. Specifically, the rubric gives a framework for assessing: construction materials applicability and

quality; information accuracy and research quality; reliability and care in data collection; construction care and organization.

2. **Post-assessment**: Administer the post-lesson assessment after the museum presentations. Like the pre-assessments, the post-assessment examines student understanding of content and level of skill associated with this lesson. A scoring guide is provided to assist teachers in measuring student learning. Specifically:
   a. Question 1 measures student understanding of habitat; answers can be compared to those to pre-assessment question 1.
   b. Question 2 measures student understanding of earthworm niches and their role in human affairs; answers can be compared to those to pre-assessment question 2.
   c. Question 3 measures student facility with and use of measurement; answers can be related to those to pre-assessment question 6.
   d. Question 4 assesses how well students use their observations to make inferences; answers can be related to those to pre-assessment question 5, as well as serving as a more general indicator of student understanding of the nature of scientific investigation.

Handouts

1. Digital Camera Checklist
2. Critter Curator Pre-Assessment
3. Pre-Assessment Scoring Guide
4. Critter Curator Post-Assessment
5. Post-Assessment Scoring Guide
6. (*optional*) Observation Task Card
7. "Meet Your Worm"
8. Critter Curator Exhibit Plan
9. Exit Cards: Day One and Day Two
10. (*optional*) Critter Research
11. Critters Research Note Sheet
12. Rubric to assess Habitat Exhibits
13. Problem Statement Task Card
14. (*optional*) Problem Discussion Board

Digital Camera Checklist

0 = Student is not able to use the camera.

1= Student is able to use the camera, with some assistance.

2 = Student is able to use the camera independently and accurately.

Student	(Prior to lesson) Readiness	(During the lesson) Assessment

Name _____ Date _____

Critter Curators Pre-assessment

1. In the space below, draw an animal in its natural habitat, showing that its life needs are met.

2. Why are earthworms important?

_____

_____

3. How do you feel about working with worms? Circle the box that describes your feelings.

5	4	3	2	1
Earthworms are cool! I can't wait!	Earthworms aren't so bad. I can touch a worm.	Earthworms are okay. I don't mind touching a worm for the sake of learning.	Earthworms are kind of creepy and disgusting, but I can touch one and live to tell about it.	Oooh, yuck! I hate worms! They are gross, and I would probably pass out if I had to touch one.

4. Have you ever visited a zoo or a museum? Tell about your experiences.

_____

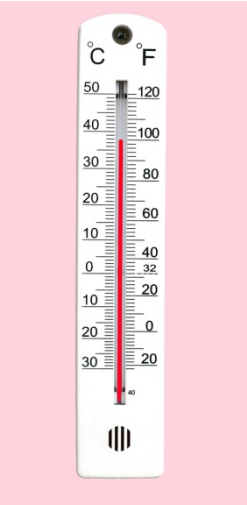
_____

5. Observation. Write at least five words to describe the object that your teacher showed you.

6. Obtain a piece of string from your teacher. Estimate the length of the string to the nearest centimeter and inch. Record your answer on the table below. Using a ruler, measure and record the length the string to the nearest centimeter and inch. Tape the string in the box below.

	Centimeters	**Inches**
My estimate		
My measurement		

7. Use the thermometer below to record the temperature:



Source: http://www.biglearning.org/photo-thermometer.jpg

	Celsius (°C)	**Temperature (°F)**
Temperature		

Pre-assessment scoring guide

Question	Evaluation Criteria	Possible Points	Total Points Earned
1	The student's picture should include multiple elements found in a natural habitat. Assign the student **1 point** for each of the following habitat elements they included: ____ an animal ____ shelter ____ space to move around ____ food supply ____ water supply	**5**	
2	The response should include at least two niches of earthworms. ____ tunneling underground which aerates the soil ____ decomposition	**5**	
3		No Points Assigned	
4		No Points Assigned	
5	Observations should include at five or more words to accurately describe the selected object. Assign one point for each word that accurately describes the object.	**5**	
6	Provides an estimate and correctly measures & records the length of the string.	**5**	
7	Records the correct temperature in degrees Celsius and degrees Fahrenheit	**5**	
Pre-assessment Score		**25**	

Name _____ Date _____

Critter Curators Post-assessment

1. In the space below, draw an animal in its natural habitat, showing that its basic needs are met.

2. What are two or more ways that earthworms help us? _____

   _____

   _____

3. How did you use measurement to plan and make your habitat?

   a. To determine the area and perimeter of the worm's habitat.

   b. To determine the type of soil to use in making the worm's habitat.

   c. To determine whether to make the worm's habitat light or dark.

   d. To determine the amount and types of barriers to put in the worm's habitat.

4. How did you use your observations to plan and create your worm's habitat?

   _____

   _____

   _____

5. Rate your effectiveness and positive contributions to the project? (How much did you help your group?) Circle a number.

   (Best) 10 9 8 7 6 5 4 3 2 1 (Worst)

6. How well do you feel your group worked together? Circle a number.

   (Best) 10 9 8 7 6 5 4 3 2 1 (Worst)

Post-assessment scoring guide

Question	Evaluation Criteria	Total Points Possible	Total Points Earned
1(Habitat)	The student's picture should include multiple elements found in a natural habitat. Assign the student **1 point** for each of the following habitat elements they included: ____ an animal ____ shelter ____ space to move around ____ food supply ____ water supply	**5**	
2 (Niche)	The response should include two or more niches of earthworms. ____ tunneling underground which aerates the soil ____ decomposition	**5**	
3 (Measurement)	(A). area and perimeter	**5**	
4 (Observations/ Inferences)	**5 Points** The student clearly explains how they used observations to make inferences about how to build their habitat. Inferences are supported through observations made during the investigations. **3 Points** The student uses some inferences made from observations and data collected from the investigations in designing his/her habitat. **0 Points** No observations, inferences, or data to support creation of habitat	**0-5**	
5 (Self-evaluation)		No Points Assigned	
6 (Team evaluation)		No Points Assigned	
Post-Assessment Score		**20**	

Observation Task Cards

Use these cards to help guide your observations.

What color(s) and markings do the worms have?	What is the shape of the worm? How might his shape help him move through the soil?	What does it smell like?
What does it feel like?	Listen to the worm. Do you hear any sounds?	Does the earthworm have teeth? How do you know?
Does your worm have eyes? How do you know?	How do you think the worm finds his way around?	Describe how the earthworm moves?
The clitellum is the area around the worm that looks like a band of skin wrapped around it. Find it and draw a picture on your sheet.	Describe anything else you notice.	Gently turn over the worm. What do you notice? Wet your hands and gently run your finger along the underside of the worm. The tiny bristles are called “setae”.

Name _____

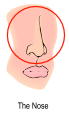
Critter Curators Day 1

"Meet Your Worm"

1. Use your senses to describe the earthworm:

 What do you see?

 How does the worm feel?



How does the worm smell?

2. Estimate the length of your earthworm and then record the actual measurement:

Earthworm	Estimate Cm	Estimate inches	Actual cm	Actual inches
Length				

3. How does the earthworm respond to touch?

When touched with a wet finger?	
When touched with a pipe cleaner?	

4. How will you use your findings to design your habitat?

Name _____

Critter Curators: Earthworm Investigation #1

Does the earthworm prefer **moist** or **dry** areas?

<table>
<tr><td>Prediction</td><td>I think the earthworm will choose a _____ area,
(moist, dry)
because_____</td></tr>
<tr><td>Materials</td><td>Moist paper towel
Dry paper towel
Plastic container
2 Spray bottles filled with water
2 Plastic cups with holes (label one Trial 1 the other Trial 2)
1 Timer</td></tr>
<tr><td>Procedure
(check off each step as completed)</td><td>1) Place a flat, moist paper towel on one half of the container.
2) Place the dry paper towel on the other side of the container.
3) Place 2 worms in the center of the container.
4) Observe the earthworms for 5 minutes.
5) Record your observations.
6) Choose 2 new worms and repeat the experiment.
7) Add your totals.</td></tr>
<tr><td>Observations</td><td>
<table>
<tr><td>The worm preferred…</td><td>Trial 1
worms</td><td>Trial 2
#worms</td><td>Total All</td></tr>
<tr><td>Moist towel</td><td></td><td></td><td></td></tr>
<tr><td>Dry Towel</td><td></td><td></td><td></td></tr>
<tr><td>Totals</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

Conclusion:_____
_____
_____
_____
_____
_____

Name _____

Critter Curators: Earthworm Investigation #2

Does the earthworm prefer **light** or **dark**?

<table>
<tr><td>Prediction</td><td>I think the earthworm will choose to be in the _____,
(light, dark)
because_____
_____</td></tr>
<tr><td>Materials</td><td>1 Flashlight
1 Opaque plastic container
1 Spray bottles filled with water
2 Paper towels
2 Plastic cups with holes (label one Trial 1 the other Trial 2)
1 Timer
Black construction paper or cardboard</td></tr>
<tr><td>Procedure
(check off each step as completed)</td><td>1) Moisten 2 paper towels and place them in the container
2) Place 2 worms in the center chamber
3) Divide the container with the black construction paper
4) Place the flashlight over the hole and turn on
5) Observe the worms for 5 minutes
6) Record your observations.
7) Choose 2 new worms and repeat the experiment.
8) Add your totals.</td></tr>
<tr><td>Observations</td><td>
<table>
<tr><td>The worm preferred…</td><td>Trial 1
worms</td><td>Trial 2
#worms</td><td>Total All</td></tr>
<tr><td>Light</td><td></td><td></td><td></td></tr>
<tr><td>Dark</td><td></td><td></td><td></td></tr>
<tr><td>Totals</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td colspan="2">Conclusion:_____
_____
_____
_____</td></tr>
</table>

Name _____

Critter Curators: Earthworm Investigation #3

Does the earthworm prefer **cold** or **warm** conditions?

Prediction	I think the earthworm will choose the _____ condition, (cold, warm) because_____
Materials	1 Bag of ice (or freezer pack) 1 Heating pad (or instant heat) 1 Plastic container 2 Spray bottles filled with water 3 Paper towels 2 Plastic cups with holes (label one Trial 1 the other Trial 2) 1 Timer 2 Thermometers
Procedure (check off each step as completed)	1) Moisten 3 paper towels and place them in the container 2) Place warm source under one side of the container 3) Place cold source on the other side of the container 4) Place a thermometer on the cold side and one on the warm 5) Place 2 worms in the center of the container 6) Observe the worms for 5 minutes 7) Record your observations. 8) Choose 2 new worms and repeat the experiment. 9) Add your totals.
Observations	

The worm preferred…	Trial 1 # worms	Trial 2 #worms	Total All
Cold ____F ____C			
Warm ____F ____C			
Totals			

Conclusion:_____
_____
_____
_____
_____

Name _____

Critter Curators: Earthworm Investigation #4

What type of **soil** does your earthworm prefer?

<table>
<tr><td>Prediction</td><td>I think the earthworm will choose _____soil,
(sandy, clay, top)
because_____
_____</td></tr>
<tr><td>Materials</td><td>Sandy soil
Clay Soil
Top soil
1 Plastic container
2 Spray bottles filled with water
2 Plastic cups with holes (label one Trial 1 the other Trial 2)
1 Timer</td></tr>
<tr><td>Procedure
(check off each step as completed)</td><td>1. Moisten 3 paper towels and place them in the container.
2. Place ¼ of a cup of each type of soil in a separate pile in the container.
3. Place 2 worms in the center of the container
4. Observe the worm for 5 minutes.
5. Record your observations
6. Choose 2 new worms and repeat the experiment.
7. Add your totals.</td></tr>
<tr><td>Observations</td><td>
<table>
<tr><td>The worm preferred…</td><td>Trial 1
worms</td><td>Trial 2
#worms</td><td>Total All</td></tr>
<tr><td>Sandy</td><td></td><td></td><td></td></tr>
<tr><td>Clay</td><td></td><td></td><td></td></tr>
<tr><td>Top</td><td></td><td></td><td></td></tr>
<tr><td>Totals</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td colspan="2">Conclusion:_____
_____
_____
_____
_____</td></tr>
</table>

NAME: _____

EXHIBIT PLANNING SHEET

Job Description:

Museum Curator: Caretaker of museum collections; often oversees an exhibit's creation and design.

Your Role:

As a Museum Curator for a local science museum, you will be designing an exhibit on earthworms. What would the exhibit feature? What would the habitats look like?

Your work will be evaluated by the following criteria:

- The **needs of the worms** are clearly met by the habitat. (mostly met/somewhat met/ not met)
- Habitat considers placement of objects or **space, amount of soil, availability and amount of water, food supply,** etc....
- The **habitat and worms are clearly visible** to the audience, people who go to the museum (mostly, somewhat, not) -at least part of the habitat should bring the worms into a visible area, so audience can observe them
- **Presentation Criteria** (eye contact, voice projection, etc.)
- **Quality of Exhibit** (thought, care, and creativity went into designing this exhibit).

You may use **print resources or online resources** on earthworm's and their habitats to help you design your "exhibit".

Critte

My Group's Exhibit Plan:

You may add this sheet to your "science log" and use additional paper to plan for your exhibit.

Based on the investigation of earthworms, what are some specific items (living and non-living) that need to be in the earthworm's habitat.

What are some other factors to consider?

Draw a picture of your earthworm exhibit on the back.

What materials will you need to construct your earthworm exhibit?

What do I need to do to support my group project?

What information do you want to include? The information needs tell more about the life of the earthworm, its niche, and how it interacts with living and nonliving things in its environment.

Name: _____

Exit Card (Day 1)

Based on what your observations, what do you think an earthworm needs to have in its habitat?

Name: _____

Exit Card (Day 2)

Based on what you observed and the data you collected, what components need to be present to create a suitable habitat for earthworms?

Name: _____

Critter Curators Internet Research

1) Complete assigned research

2) Use what you learned to select a container to create your habitat exhibit.

You will be assigned one of the following websites to research. Circle your assigned website. Use the back of this paper to take notes about what you learn. The websites will help you gain information to learn more about earthworms and their habitats. You will use what you learned to create your museum exhibit.

Website 1: "The Adventures of Herman the Worm"
http://urbanext.illinois.edu/worms/

Website 2: "Yucky Worm World"
http://yucky.discovery.com/flash/worm/

Website 3: Kids National Geographic Worm Site
http://kids.nationalgeographic.com/kids/animals/creaturefeature/earthworms/

Website 4: "BioKIDS" Earthworm Site
http://www.biokids.umich.edu/critters/Oligochaeta/

Name _____

Earthworm Research Notes:

Information about earthworms:

Information about the earthworm's habitat:

Information about the earthworm’s niche (job):

Other interesting information about worms:

Based on what I have learned, what are some materials that I need to include in my worm habitat exhibit:

I selected a _____ for my container because _____

_____.

Building A Structure : Critter Curators

Student Name: _____

CATEGORY	4	3	2	1
Construction - Materials	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.
Information Gathering	Accurate information taken from several sources in a systematic manner.	Accurate information taken from a couple of sources in a systematic manner.	Accurate information taken from a couple of sources but not systematically.	Information taken from only one source and/or information not accurate.
Data Collection	Data taken several times in a careful, reliable manner.	Data taken twice in a careful, reliable manner.	Data taken once in a careful, reliable manner.	Data not taken carefully OR not taken in a reliable manner.
Construction - Care Taken	Great care taken in construction process so that the structure is neat, attractive and follows plans accurately.	Construction was careful and accurate for the most part, but 1-2 details could have been refined for a more attractive product.	Construction accurately followed the plans, but 3-4 details could have been refined for a more attractive product.	Construction appears careless or haphazard. Many details need refinement for a strong or attractive product.

Problem Statement Task Card:

The Children's Museum of Science is searching for teams of student curators to design a habitat exhibit on earthworms. As student curators, your job description will include: close examination of the species, investigation of its needs, and careful engineering of a habitat. Student curators must keep the audience, children who will attend the museum, in mind as you plan.

Critter Curators Problem Discussion Board

What do we know?	What do we need to know?	How can we find out?
Questions?		