Instruction Using the Earthworm and Pig

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This article shows how the earthworm and pig can be used in 2 very different types of instruction. Direct instruction is highly teacher directed and is among the most commonly used. It is an instructional sequence that includes demonstration, controlled practice with prompts and feedback, and independent practice with feedback. In order to teach specific content, teachers employ objectives and lesson plans related to overall curriculum guides. This strategy is effective for providing information or developing step-by-step skills. It also works well for involving students in knowledge construction.

On the other hand, indirect instruction is mainly student-centered. This means the role of the teacher shifts from lecturer/director to that of facilitator, supporter, and resource person. The teacher arranges the learning environment, provides opportunity for student involvement, and, when appropriate, provides feedback to students. An example of indirect instruction is inquiry learning.

The inquiry method is a student-centered approach to teaching in which students explore, investigate, search for information, discover, and seek solutions—with guidance from the teacher. The process of inquiring begins with students gathering information and data. They learn to apply their senses—seeing, hearing, touching, and smelling. They become active learners while the teacher guides and facilitates. They learn to identify their own problems and carry out investigations with little teacher assistance.

Inquiry-based activities provide opportunities to address different types of learning goals. By encouraging students to think in an increasingly complex way, inquiry-based activities allow learners to select and transform information, construct hypotheses, and make decisions. Students collaborate with each other, and anxiety levels decrease as they begin to feel in control of their own learning.

The Earthworm—Direct Instruction

Going fishing? When most people think of earthworms, fishing is one of their first thoughts. Because of their popularity, earthworms are probably the most recognized invertebrate (Fig. 1). Even though most students are familiar with earthworms, they probably have not taken the time to examine them closely.

Earthworms are members of the phylum Annelida, the segmented worms, and belong to the class Oligochaeta, with the most familiar genus being Lumbricus. They can be found in most soil types and in all regions of the world, except in deserts and frozen areas. Since they need to be moist to breathe and to replace the water they lose through urination, they must have water in their environment, which means they live in soil containing 35 to 75% water.

Earthworms have no eyes or ears, but they can distinguish light/dark and are sensitive to vibrations. They have an undeveloped sense of smell and rely on their sense of taste.

Earthworms eat organic matter, consisting of decomposing plants and animals, animal
The easiest way to teach the internal anatomy of the earthworm is to break it down into systems.

**Dissecting Earthworms**

Using the information in Table 1, teach students about the systems of the earthworm and prepare them to do the dissection. Find a good picture of the anterior end of the earthworm, make a copy for each student, and create an overhead transparency. As you teach the parts of the external and internal anatomy, place the transparency on the overhead and label the parts. Assign a different color to each of the systems; for example, use blue for the digestive system. Have students write on their picture of the earthworm: “digestive system—blue.” As you talk about each organ in the digestive system, have students label the parts in blue. They should use their labeled picture for help when they dissect the earthworm. The following are inquiry-based extensions. Students can:

- Predict, then count the number of segments on the earthworm.
- Record its length.
- Record how many segments there are between the mouth and the clitellum.
- Make a sketch of the earthworm and label the organs.
- Describe the appearance of the organs.
- Compare the crop and gizzard.
- Discuss one part of the internal anatomy that was most interesting.

**Observational Skills**

Have students pick an earthworm and answer the following questions. What color is the worm? Is it the same color on the ventral and dorsal surfaces? How does the worm’s epidermis feel? How are the posterior and anterior ends the same? How are they different? They also can describe their worm or draw a picture and label its mouth, anus, clitellum, segments, dorsal surface, ventral surface, posterior, and anterior.

**Environment**

Living earthworms can be kept in the classroom for extended periods. Allowing students to do this enables them to learn about the earthworm's importance in the ecosystem. If your class “farms” earthworms, you can meet the national standards that require students to determine the characteristics of living things, their habitat, and their movement. Each student can keep her own earthworm bin, a container in which earthworms live and eat refuse. The bins are easy to set up and maintain. Students can even use 2-liter bottles as bins.

To set up an earthworm bin, begin with a plastic container with holes drilled in the top. Place one large handful of soil in the bottom and add the earthworms to the container. Shred newspaper or paper and put it on top of the worms. The shredded paper serves as bedding, and the worms eat it over time. Material

### TABLE 1

<table>
<thead>
<tr>
<th>Organ</th>
<th>Structure/Function</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain</td>
<td>Sends signals to the body</td>
<td>Segment 3</td>
</tr>
<tr>
<td>Ventral nerve cord</td>
<td>Carries information to and from the brain</td>
<td>Runs length of body</td>
</tr>
<tr>
<td>Ganglia</td>
<td>Groups of nerves</td>
<td>Along the nerve cord</td>
</tr>
<tr>
<td>Digestive System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouth</td>
<td>Opening at the anterior end; takes in food</td>
<td>Segment 1</td>
</tr>
<tr>
<td>Pharynx</td>
<td>Muscular and tubelike (looks like a light bulb); pulls in food and sends it to the esophagus</td>
<td>Segments 3–6</td>
</tr>
<tr>
<td>Esophagus</td>
<td>Narrow passage for food; moves food to the crop</td>
<td>Segments 7–14</td>
</tr>
<tr>
<td>Crop</td>
<td>Thin-walled storage chamber; digests and moves food to the gizzard</td>
<td>Segments 14–16</td>
</tr>
<tr>
<td>Gizzard</td>
<td>Thick-walled, muscular organ; expands and contracts, using sand grains to grind food</td>
<td>Segments 17–18</td>
</tr>
<tr>
<td>Intestine</td>
<td>Largest internal organ; absorbs digested food into the body</td>
<td>Segments 19 to end</td>
</tr>
<tr>
<td>Circulatory System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic arches</td>
<td>Functions like human heart; 5 pairs connect and pump blood through the dorsal and ventral blood vessels</td>
<td>Segments 7–11</td>
</tr>
<tr>
<td>Dorsal blood vessel</td>
<td>Carries blood to the anterior end of the body</td>
<td></td>
</tr>
<tr>
<td>Ventral blood vessel</td>
<td>Carries blood to the posterior end of the body</td>
<td></td>
</tr>
<tr>
<td>Reproductive System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ovary</td>
<td>Holds the eggs</td>
<td>Segment 13</td>
</tr>
<tr>
<td>Seminal receptacles</td>
<td>Receive and store sperm from the “male”</td>
<td>Segments 9–10</td>
</tr>
<tr>
<td>Testis</td>
<td>Produces sperm</td>
<td>Segment 10</td>
</tr>
<tr>
<td>Seminal vesicles</td>
<td>Store sperm before it is sent to the seminal receptacle in the “female”</td>
<td>Segments 9–11</td>
</tr>
<tr>
<td>Vas deferens</td>
<td>Swollen lips found on the external, ventral surface; where sperm enters</td>
<td>Segment 15</td>
</tr>
<tr>
<td>Excretory System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anus</td>
<td>Releases solid waste called castings</td>
<td>Posterior end of the worm</td>
</tr>
<tr>
<td>Nephridia</td>
<td>Bladderlike organ; releases liquid waste</td>
<td>All segments except first 3 and last</td>
</tr>
<tr>
<td>Respiratory System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td>Breathes by osmosis; for the exchange of oxygen and carbon dioxide to occur, the earthworm’s skin must be moist</td>
<td></td>
</tr>
</tbody>
</table>
Behavior

Turn the lights off in the classroom. Place an earthworm on a wet paper towel. Students should shine a flashlight on the worm and record its reaction. Give students 2 flashlights, one covered in green cellophane and one covered in red. Shine the flashlights on and around the worm. Which color does the earthworm prefer?

Have students place a wet paper towel on one side and a dry paper towel on the other side of a plastic shoebox or other container. Place an earthworm in the middle of the container. Which side does the earthworm prefer?

Place an earthworm on a wet paper towel. Using the end of your pencil, brush very lightly against one end of the worm. How does it react? Have students draw a picture of how the earthworm moves.

Put 2 earthworms at separate ends of a covered container. Ask students to write down their observations. The earthworms should move toward each other. Place the earthworms on the soil in their bin. Do they stay on top of the soil?

Other Activities

You can use earthworms in several simple math activities. Students can practice by measuring gummy worms, then measure several worms, calculate their average length, and graph the data. In addition, ask students to weigh and record the types of food they feed to their worms. They should record how long it takes the earthworms to eat each type of food and graph their data. They should record how much is left over food in the container, making sure it is completely covered by the paper.

Before setting up the bins have students research composting, earthworm bins, and vermicomposting. You can start by posing the following scenario: The school has been told by the landfill that it must reduce its waste. How can we reduce the amount of waste that leaves our classroom? Students should illustrate the vermicomposting cycle, including designing the bin, feeding the earthworms, and using earthworm waste. Have them think about how the earthworm waste might be used. They can also design extensions for this project; for example, they can list the food they had for lunch and trace it back to the earth.

The Pig—Indirect Instruction

The domestic pig, Sus scrofa domesticus, belongs to the class Mammalia, the mammals, which have hair and mammary glands. The pig is a member of the order Artiodactyla, the even-toed ungulates. It shares this order with the cow and deer. It is an omnivore, eating both plant and animal matter. The life span of the pig is 15 to 20 years, and an adult may weigh up to 900 lb (400 kg).

Outline the Investigation

Tell students they will be dissecting a pig. Do not teach them the parts of the pig; instead, have them learn the parts on their own (Fig. 3). Divide students into pairs, assigning different systems of the pig to each pair, and assign which organs students should find within each system. Table 2 suggests an outline of study for 4 pairs of students.

Preparing for Dissection

Before beginning the dissection, identify the appropriate tools and help students discuss the important issues. You may use pictures on an overhead projector or use a PowerPoint® presentation. Students may use scalpels, but this dissection can be done with scissors.

Tell students they will be responsible for gathering information and teaching others about their assigned system(s) and organs, and their functions. Give them the opportunity to use lab manuals, the Internet, and science books to find information.

Since skin incisions for beginning the dissection are different for male and female pigs, students should use lab manuals to determine the sex of their pig and how they should proceed. Suggestion: At this point have students tell you the sex of their pig and how they plan to begin the dissection.

Let Students Teach

Once students have identified the organs and functions within their assigned systems, they teach the information to other groups. Each pair of students consists of a Recorder and a Traveler. The Recorder is responsible for keeping a summary of the pair’s information, and he teaches/identifies the organs and explains their functions to Travelers from other pairs.

The Recorder’s partner is the Traveler, who goes to the other pairs and learns about the other systems and organs of the pig. When the Traveler has completed a visit to all the other groups, she returns and teaches the Recorder.

During this inquiry activity, teachers are facilitators,
under the microscope

Estimating Size Under a Microscope

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Here’s a simple exercise to show students how to estimate the size of objects viewed under a microscope.

Materials Needed

• Prepared microscope slides:
  - Corn Stem, c.s. (CT-30-3296)
  - Onion Root Tip, l.s. (CT-30-2378)
• See-Through Plastic Ruler (CT-70-2606)

Background

It’s easy for students to determine the magnification of what is seen under a microscope. Multiply the magnification of the ocular lens (usually 10×) by the magnification of the objective lens (scan = 4×; low = 10×; high = 40×, etc.) to give the total magnification. Using the numbers above, an item viewed on scan would be magnified 40× its natural size; on low power, it would be magnified 100×; and on high power, 400×.

However, it’s not quite so easy for students to determine the size of the objects they are viewing. You might begin by explaining that the unit of measurement used in microscopy is the micrometer (micron) or µm. Make sure they understand that there are 1,000 µm in 1 mm and 1,000 mm in 1 meter. Therefore, there are 1,000,000 µm in 1 meter.

First, students determine the diameter of the field of vision for the lowest magnification of their microscope. To do this, they place the metric side of a ruler on the stage of the microscope. Using the lowest-power objective, they count the number of mm units of the ruler they see. If they can see 3 units, then they are seeing 3 mm or 3,000 µm. If they see 31/2 units, they are seeing 31/2 mm or 3,333 µm.

High-Power Field of Vision

Consider the following example. The ocular lens is 10×, the lowest-power objective is 4×, the high-power objective is 40×, and the diameter of the field of vision with the 4× objective is 3,000 µm. The ratio of high-power objective to lowest-power objective = 40×/4× = 10/1 = 10. Then the diameter of the high-power field of vision equals the diameter of the lowest-power field of vision (3,000 micrometers) divided by 10 (the ratio of high-power to lowest-power objective), which equals 300 µm.

Students should determine the diameter in µm of the high-power field of vision for their microscope and record it. Have them check to see if the height of the field is the same as the width.

Measuring the Size of Cells

Next, students use the corn stem cross section and the microscope on low power or scan to observe the following:

• Epidermis
• Vascular bundles
• Large parenchyma cells

They change to high power and focus, then measure any cell types that fill the diameter of the field of vision. For example, if the diameter of the high-power field of vision is 300 µm, and if a row of 12 parenchyma cells are counted across the field of vision, then the average cell diameter equals 300 µm divided by 12, or 25 µm. They should move the slide until they have a row of parenchyma cells across the widest part of the high-power field of vision, then count the cells in the row and calculate their average diameter.

Average parenchyma cell diameter = ________________µm

Measure epidermal cells in the same manner.

Average epidermal cell diameter = ________________µm

To determine the diameter of the corn stem, they place a square of paper over half of it. Using the straight edge of the paper as a guide, they count the number of cells across the stem. Now they multiply the number of cells across the stem times the average cell width. Example: 125 cells × 25 µm = 3,125 µm. Using the ruler, they then measure the width of the corn stem (remember, 1 mm = 1,000 µm) and compare the 2 answers. Differences may be attributed to the fact that they are using the average cell width, and the fact that not all cells are in a straight line.

Using the onion root tip and the microscope on low power, they observe the root tip and note the following areas:

• Root cap
• Meristematic area
• Area of cell elongation

Using high power they pick an area in the meristematic region and count the cells as before. They should count the cells running in the up-and-down direction. Now they can figure out the average width and height of the cells. Then they do the same with the area of elongation and compare it with the meristematic region. Now, having determined the size of a cell and the size of the viewing area, students should be able to estimate the size of anything they look at under the microscope.