Aquatic Systems #1

Goals

Students develop their knowledge of systems and subsequently create an aquatic microcosm according to their own specifications for how such a system should work.

Introduction

Webster's II tells us that the word "system" comes from *sunistanai*, to combine: *sun-*, together + *histanai,* to make stand and defines it as a group of interrelated, interacting, or interdependent constituents forming a complex whole; harmonious.

Outcomes

Student groups use their knowledge of the retention ponds to develop their own microcosms.

Evaluation

The microcosm and rationale for substrate and plant choices are the assessment tool. Student science notebooks document small group work and plans.

Do Ahead

Contact local aquarium stores and science catalog companies for best deals on plants and animals. Find out how long it will take to fill an order.

Collect/purchase enough gallon jars or aquaria to provide each group with its own. This may take a substantial amount of time (it took me five months), so start way ahead of when you wish to begin the unit.

Vocabulary

- sustainable
- microcosm
- system
- substrate
- model
- simulation
- photosynthesis
- growth
- reproduction
- survival
- energy cycle
- producers
- consumers
- decomposers

Materials

Water garden* (1/class)
1-gallon jars** (1/group)
Student Handout #3 Aquatic plant list (1/student)
Student Handout #4 Substrate list (1/student)
Student Handout #5 Animal list (1/student)
Measurement tools (thermometers, rulers and tape measures, hand lenses, CBL/LabPro probes, triple-beam balances, calculators)
transparency of Webster's II definition
transparency of group plant choice sheet
Student Handout #6 Plant choice record (1/student and 1/group)
Folder (one/group) labeled with table group number and members

Time Required

Two-three class periods to design microcosm and order organisms
Variable time to fill plant and animal orders

Procedure

1. Place a transparency of the Webster's II definition on the over-head projector and use it as a conversation starter about systems.
    a. describe how the retention ponds are a system.
    b. list their components.
    c. tell how they interact, etc.
2. From this discussion, ask students to abstract the components of an aquatic system and write them in their notebooks.
    a. what makes up an aquatic system
    b. how does it work
    c. with your group decide your answers to 2a & b and write them in your notebooks.
3. To reinforce the idea of system and prepare students to make informed microcosm choices, begin a discussion of aquatic organisms. Ask:
    a. What do aquatic organisms need to live?
    b. How are their needs met?
    c. What happens if their needs are not met?
    d. What do these organisms contribute to their environment?
    e. What do they take from it?
    f. How do they change the environment?
4. Under each question note their responses on an overhead transparency or chart paper (date it). Tell students to take these same notes in their notebooks. The dated transparency serves as a record of the discussion ideas to refer back to and can also be

electronically copied for absent or special needs students and for the teacher's notebook.

5. Introduce the classroom Water Garden*. *This can be introduced piece by piece as substrate, plants, and animals are placed and the lighting set up. Carolina does include directions for start up and a list of plants with a brief description of each, but no pictures and no scientific names. Identification is iffy because of the incredible similarity among aquatic plants and the number of different common names for the same plant. The Water Garden can be introduced fully assembled too. Because I didn't want the kit contents to influence their choices, I introduced it fully assembled.*

6. Elicit from students their ideas about the water garden's system-ness;
    a. what makes this a system?
    b. what are its components?
    c. how do they interact?
    d. what do you need to know/do to make it work?

7. Take notes on a dated transparency.

8. Also label it an aquatic microcosm---a small working example (built or natural) of a larger ecosystem. The terms model and simulation may arise here. A model for us was a built (not naturally occurring) example of either a built ecosystem (retention ponds) or a natural ecosystem (natural ponds) that had all the characteristics of a real pond. A simulation is an imitation (that produces test conditions similar to actual or operational conditions) of an existing system or one to be created. These are subtle distinctions.

We weren't attempting to build a model or a simulation of the retention ponds. We were attempting to produce different models of sustainable aquatic environments and study within interactions (intra-system analysis) and compare one with another (inter-system analysis).

9. *For convenience, you may wish to refer to the Water Garden as the classroom pond, as opposed to the outside (retention) ponds or the jars (the students' sustainable aquatic microcosms).* Tell students it (the classroom pond) is sustainable because after it is set up, nothing is added to it but water (in the real world, precipitation and springs or other underground water would add water). Nothing is given to it but light (in the real world, the sun provides that). Nothing is taken from it. No pump is necessary to supply oxygen. No food is given to the animals. If everything is balanced (harmonious), the unit functions as a self-contained, continuously regenerating, regulating system. The plants convert light energy to food, grow and reproduce, and provide dissolved oxygen. Animals eat the plants, use the dissolved oxygen, and grow. They produce waste material that feeds the plants. The container size and appropriated student choices of plants and animals, limit the size plants and animals will attain. Balance. *All of this information is presented to students via discussion of sustainable, systems, needs, contributions, and effects.*

10. Give students their jars and the lists of substrates, plants, and animals. *A poster of aquatic plants is displayed so students can see what they look like.*

11. Tell students to use their lists to design their own microcosm that is

sustainable. Each student may choose up to five different plants. S/he must select a substrate appropriate for those plants, and list animals s/he would like to add. They are required to state the rationale for their choices and how that combination will be sustainable.

12. After individuals have completed their own lists, they meet with their table group to negotiate their choices and create one list for one environment for the entire group. Using reason, argument, and evidence groups produce a collaborative list and rationale.

13. Groups then present their decisions and reasons to the class and submit their lists, both individual and table group, to me. *Plants and animals are ordered for the groups from their table group list. Ordering can be done locally from an aquarium store or through science catalogs. I've used both. Time required to fill an order can take anywhere from immediately (locally in stock) to several weeks. Be sure to talk to both local merchants and catalog companies in advance to find out what time frame you will have.*

14. Make copies of all forms before returning both the individual and group lists (1 copy for each student) which they staple into their science notebooks as their record. Keep the originals for ordering and your own records.

*Water Garden: This is a 15-20 gallon black plastic container wider at the lip than at the base. It can be ordered as a kit complete with substrate, a collection of aquatic plants, and a number of snails from Carolina Biological Supply for less than $60. There is no pump.

A plant light is necessary to supply adequate light for photosynthesis within the water garden. These bulbs can be costly and we have used cold fluorescent bulbs. An interesting experiment would be to try both conditions and compare results.

Last year our water garden crashed completely once--everything had to be replaced--and died back to near crash two more times (many plants and animals had to be replaced, but not all) before we were able to stabilize it. All three experiences were wonderful learning opportunities as we attempted to figure out what caused the crash and prevent another.

**1-Gallon Jars: Glass jars this size are difficult to obtain except by purchasing them as containers for a product such as pickles. Canvass your students' families for what they may have at home first. If all else fails, go to Sam's and buy gallons of pickles. You can sell the pickles at lunch to the student body as a fund-raiser and keep the jars. This is the cheapest method for obtaining suitable containers.

Plastic gallon jars are easier to obtain (lots of products come in them) and will certainly work, but over time the contents of the microcosm will discolor and build-up on plastic walls obscuring the view, but not on glass. Plastic has the advantage of being less likely to break if dropped and they can be replaced yearly.

Finally, the jar mouth size is barely adequate for satisfactory oxygen exchange. This can create a problem for plants and animals. Small glass aquaria would actually be better for oxygen exchange, but cost is a consideration. Perhaps some families would be willing to donate their old ones as a starter and one or two can be purchased each year. Again, an experiment would compare identical plants and conditions, varying only which size opening the container had.

All of the following Wisconsin science content standards are directly addressed throughout this unit on aquatic systems: