Lesson: Build your own Aquaponics Garden

Marissa Blanco-Johnson- Liam Conner- Hazel Krane- Kylie Rostad-
Tallulah Shepherd- Wildon Uyeda

Grades: K - 2
Subject area: Ecology
Class size: 6 classes of 25 students
Time required: 30 minutes per class
State Curriculum Standards:

Kindergarten
Life Sciences
2. Different types of plants and animals inhabit the earth. As a basis for understanding this concept:
    c. Students know how to identify major structures of common plants and animals (e.g., stems, leaves, roots, arms, wings, legs).
Investigation and Experimentation
4. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
    a. Observe common objects by using the five senses.
    b. Describe the properties of common objects.

First Grade
Life Sciences
2. Plants and animals meet their needs in different ways. As a basis for understanding this concept:
    a. Students know different plants and animals inhabit various kinds of environments and have external features that help them thrive in different kinds of places.
    b. Students know both plants and animals need water, animals need food, and plants need light.
    c. Students know animals eat plants or other animals for food and may also use plants or even other animals for shelter and nesting.
    e. Students know roots are associated with the intake of water and soil nutrients and green leaves are associated with making food from sunlight.

Second Grade
Life Sciences
2. Plants and animals have predictable life cycles. As a basis for understanding this concept:
    e. Students know light, gravity, touch, or environmental stress can affect the germination, growth, and development of plants.

Earth Sciences
3. Earth is made of materials that have distinct properties and provide resources for human activities. As a basis for understanding this concept:
    e. Students know rock, water, plants, and soil provide many resources, including food, fuel, and building materials, that humans use.

Content:

Students at Stonehurst Elementary will be taught about the newly constructed aquaponics garden in their greenhouse by creating a small, take home system, that the students can keep. As they construct their scaled system, they will be taught about the integral components of aquaponics, and how each part sustains the plants and the fish. To conclude, they will then apply the knowledge acquired through a tour of their large scale greenhouse aquaponic system.

Prerequisites:

Students must have basic knowledge concerning living things (fish need water and food to live), be capable of following directions given to them by an authoritative source, and basic health and safety knowledge concerning glass tanks and live animals. They must understand that all organisms have requirements for life and produce waste products.

Background:

Aquaponics is the combination of conventional hydroponics and aquaculture in a new way. Hydroponics is a method of growing plants in nutrient rich water, without soil in an enclosed area. Fish farming, or aquaculture is the farming of aquatic organisms i.e. fish. Aquaponics is a sustainable system that combines both methods, by filtering the water between plants and fish continuously.

Aquaponics was created to combat the issues and complications of conventional fish farming. Problems such as: the used harmful chemicals and pesticides to control the health of the fish, waste released into the surrounding environments, and uncontrollable nitrates. Combining it with hydroponics solves these problems by creating a healthier environment for the fish to live in, due to the nutrients released by the plants, and it becomes completely sustainable. The waste is cycled between the fish and the plants, creating a symbiotic relationship, leaving few additional pollutants. The plants will take in carbon dioxide and release oxygen, which will combat the ammonia released by the fish waste in a process called nitrification.

The modern developments of aquaponics is generally attributed to the works of the New Alchemy Institute and Dr. Mark McMurty of North Carolina State University, but information and papers about the topic have been found from nearly a decade before. These papers lead other people, such as Tom and Paula Speraneo, to create their own aquaponics greenhouses, and make their own adjustments to edit the theory. In 1997, the Aquaponics Journal publication was initiated by John S. Pade and Rebecca L. Nelson, in order to bring together research and application from people around the world.

Objective:

1. Students will understand the components of an aquaponics system, and how they function together.
2. Students will understand the differences between oxygen and carbon dioxide and understand the basic principles of photosynthesis and respiration.
3. Students will understand the basics of plant and fish life, including waste products and needs.
4. Students will obtain the ability to secure and maintain a healthy aquaponics system in their own homes, and will be part of the team taking care of the larger scale system at Stonehurst Elementary.

Materials (per student):

- Clear plastic bottles (2 liter, with tops cut off)
- Gravel (1 handful)
- Chlorine free water
- Fish (Minnows, Goldfish)
- One vine of Pothos containing at least 4 leaves.

Preparation:

Three stations must be set up, on separate tables. One with gravel of various colours, one with purified water and fish, and the last with plants, fish food, and fish care guides.The tanks must be clean and healthy, any damaged plants or fish removed before the laboratory is begun. Some of the plants must be on a bucket on the table, so as to be visible to the students, and the rest must be in a box underneath the table, so they will stay healthy and ready for use. The bottles, given that they will be used to carry the fish and plants the students will take home, must be washed out thoroughly, so no contaminating traces can remain. The gravel must be rinsed through again, to get rid of any dirt, or unhealthy bacteria, or waste.

Procedure:

Step 1: To set up for our lesson, we arrived at the school thirty minutes early, to check in with the offices, and to alert the teachers that we would be starting soon. We had to set up and clean off tables, to make the environment safe for children. {One station for gravel, one for water and fish, and one for plants, fish food, and care guides}

Step 2: We set up a station for our teacher to cut the tops from the plastic bottles the students would be using for their habitats. The first presenter placed the freshly rinsed gravel in separate plastic cases, to make it easier for the class to reach. The second presenter filled a large crate with water from a tap, and released two tablespoons of water purifier into the mixture. After waiting for it to be safe, and checking the respective temperatures of the waters, we released the fish into the crate, and cleaned the nets to be ready for use. The third presenter filled one bucket with plants, and placed it on the table, to be more visible, and placed the rest under the table to protect it from the sun. The presenter then went on to cut out damaged or unhealthy leaves from the plants, before the students arrived. A presenter was also sent to check on the greenhouse, to make sure it was safe and ready for students.

Step 3: We began the lesson by introducing ourselves, and our teacher explained to the students what QuikSCience was, and what we were planning to teach them. Then each respective presenter went by explaining and asking the students questions about their own sections. The included questions were such as ‘Do plants breathe?’ and ‘What are the waste products of fish?’

Step 4: We continued to ask questions while our teacher cut the tops from their bottles, and the students began to set up their habitats.

Step 5: At the first station, a student would have to answer a question correctly in order to collect their gravel for their habitat. Questions such as, ‘Why do we need gravel in the system?’ The question would have to be answered correctly before the student could proceed to the next station.

Step 6: They would then continue to the next station, where they would answer a question asked to them by the second presenter, before they would fill their bottles up with the purified water. Questions such as ‘Do fish breathe?’ and ‘What are some of the fish’s waste products?’ They would then take a net, and pick out a fish they wanted, with help from the presenter. The

presenter then would transfer the fish from the crate, into their bottle, and the students would be allowed to continue to the next station.
Step 7: At the next station, they would answer questions such as 'Do plants breathe?' and 'What is the element plants let out, and what's the compound they breathe in?' They would each receive four plant leaves to place in their bottle and pick up a package of fish food and a care guide.
Step 8: They would then continue to the greenhouse, in which they would take a tour, and wait for the rest of their class to be finished. They would then briefly go over proper care for their plants and fish, before going back to class.
Step 9: Clean up included giving several example systems away to the office, and recycling any extra bottles at the school's recycling bins. We placed the fish back into their small tank, and put the remaining gravel and plants into a box, and left any extra fish food with the class teachers.

Evaluation:

To determine if our lesson was successful, and to see if the students were paying attention, at each station, the students would answer a question about the lecture, and if they got it right, they are allowed to get their materials, and proceed to the next section. The presenter handing out fish would ask questions pertaining to fish and their functions, and so on. The final check was a tour of their own aquaponics greenhouse, and their teachers will be checking up on the students to see if they have been able to retain enough information to successfully continuously take care of the fish.

Follow-Up Activities:

The follow-up activities will be taking their aquaponics systems home, transferring them into a more permanent habitat, and maintaining the health to keep the fishes alive and functioning for as long as possible.

Self-Assessment:

Our lesson and it's execution went better than we had expected. We had thought to face some set backs, due to the age of the students we were teaching, most of them ranging from four to seven. We had imagined it would be harder to obtain and maintain their attention, and for them to retain the information given. We'd also expected more difficulties with the use of live animals, and keeping the plants healthy through out the day, given the heat of the day, and the outdoors environment. But after our brief lecture to start off the lesson, an explanation of the basics of life and ecosystems, the students formed a line to go from station to station to complete their own system. First their bottles had to be cut at the top by a teacher, and the children had to be kept back for safety. They then continued onto *Presenter 1,* who had the freshly rinsed gravel in separate boxes, and they took a handful of gravel each, while answering a question about the previous lecture. They then continued onto *Presenter 2*, who had the large crate of fish and purified water, and each student was allowed a net to pick out the fish they wanted, and the presenter would transfer the fish into their habitat along with the water, and while the students correctly answer the presenter's question. They continued to the last student presenter, *Presenter 3*, and get four leaves of the pothos plant, and place them into their water, while answering another question. Finally, they took a small package of fish food, and follow their teacher to the aquaponics greenhouse we set up at Stonehurst, where they would take a tour, and review what they had to do to keep the class healthy. The students remained interested and involved

throughout the whole lesson and the teachers seemed very impressed with the lesson plan, how it was executed, and their own students' interests. In conclusion, we were very pleased with our plans and results, and how the student's continuous excitement with our project and their home systems.

Lesson Outline:

I. About us
- A) Who are we?
  1) We are Zoo Magnet High School students, participating in the QuikSCience competition.
  2) Every member of the group should introduce themselves with a name and grade
  3) Explain that we are trying to create a campus based functioning Aquaponics unit, like the one being built in the greenhouse of their school.
- B) QuikSCience
  1) A ocean based, environmental, science competition sponsored by USC and Quiksilver
  2) Asks students to choose an aquatic problem and come up with a solution.

II. Our Plan
- A) Our Problem: Aquaculture
  1) Also known as fish farming.
  2) Fish farming can be good.
     a) They don't take fish from the wild.
     b) Forms are cheaper and easier to maintain than commercial ocean fishing operations.
  3) But they can also be bad.
     a) Greater need for pesticides or other harmful chemicals.
     b) If a fish accidentally gets loose, it will be in competition with native species for food and space.
     c) Produces a high quantity of waste, and no natural ways to use or get rid of it.
     d) Has no way of dealing with the ammonia released from the fish, which poisons the water.
- B) Our Solution: Aquaponics
  1) Aquaponics is a system combining conventional hydroponics and aquaculture
     a) Hydroponics means cultivating plants in nutrient rich water
     b) Aquaculture is fish farming.
  2) Pros:
     a) The waste produced by one is used by the other, creating a mutually beneficial or symbiotic relationship.
     b) You can raise both plants and fish simultaneously
     c) It's healthier for the environment, and creates a healthier cycle within the systems.

d) The oxygen released by the plants combats the nitrates (Ammonia) and stops the tank and food from being poisoned.
e) Much less chemical waste.

3) Cons:
a) More expensive than conventional fish farming.
b) Harder to maintain on a large scale.
c) Diseases will spread more easily due to the continuous water cycling between the plants and the fish.

III. Building the systems

A) Habitat
1) A habitat is a place for the plants and fish to live and grow.
2) We will be using a clear plastic bottle, so light can be let into the system.
3) Remove the lid of the bottle, and cut it open. Keep the top to the side.
4) Why is it important?
1) Provides light and a place to live.

B) Gravel
1) Used to stabilize the bottle, ground the plants, and retain the good bacteria.
2) Students must take one handful of gravel of their own color choice for their bottle.
3) Why is it important?
1) Good bacteria that lives on the gravel will turn waste into fertilizer for the plants.

C) Water
1) All living things need water to live.
2) Make sure the water is chlorine free because chlorine will kill the fish.
3) Why is it important?
a) *Everything* needs water to live.

D) Fish
1) Students must take one fish.
2) Why do we need fish?
a) In a larger scale system, the fish raised can be eaten.
b) They complete the relationship, and will create a healthy tank.
c) They can be ornamental due to their color.
2) Do fish breathe?
a) Yes. They don't breathe air, they breathe oxygen from the water through a process called respiration.
b) When they exhale they produce carbon dioxide, which is then absorbed by the plants.
3) Waste.
a) Chemicals inside their waste (ammonia) will poison the fish, unless it is filtered out.
b) The fish takes oxygen out of the water, and puts waste and carbon dioxide into it.
4) Why is it important?
a) It maintains the balance of the tank.
b) They will be kept as pets.

E) Plant
    1) The plants we will be using are called Pothos.
    2) Turn the top of the bottle upside down and place it inside of your bottle.
    3) Pick four leaves of the plant, and let them sit inside the hole at the top, making sure the bottom of the roots touch the water.
    4) About the plant:
        a) Plants are alive.
        b) What do they need to live?
            i) Light.
            ii) Water.
            iii) Fertilizer, which they will get from the fish waste, and bacteria in the gravel.
            iv) Carbon Dioxide, which the fish release.
        c) The process of absorbing carbon dioxide and releasing oxygen is called photosynthesis.
    5) Why is it important?
        a) To clean the water for the fish.

IV. Taking care of your miniature ecosystem
A) When the students take the structure home, they should transfer the fish and plants into a larger glass vessel as soon as possible.
B) Keep the aquaponics garden inside the house next to a window, so the plant can be exposed to a normal light cycle.
C) Feed the fish 1-2 flakes of food a day.
    a) If a student forgets to feed a fish, the fish can also eat plant roots, so do not overfeed the day after missing a feed. This can cause disease or even death for the fish.
D) Add water that is chlorine free. You can either:
    a) Buy chlorine free water.
    b) Use a filter to clean tap water.
    c) Use dechlorinating drops sold at the pet store.
    d) Just leave tap water out for 24 hours, the exposure makes the chlorine evaporate into the surrounding environment.

V. Learning more
A) Visit the QuikSCience website for information about the project.
B) Visit http://teamaquaponics.webstarts.com/ to learn more about Aquaponics and our project and upcoming plants and event.
C) Visit the Aquaponics garden at Stonehurst Elementary.