Duckweed Project lesson plan

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The Duckweed Project covered specific LPS science objectives, by providing inquiry-based lessons that included hands-on experiments with duckweed. The suggested minimum time for an effective classroom experience with the Duckweed Project was 4 weeks (1 hour per week)—a total 4 hours in the middle schools’ classrooms.

This lesson plan relates to three Nebraska Science Education Standards – Grades K-6 to K-8. These include: SC2.3.1.a Differentiate between living and nonliving things; SC8.1.1 Design and conduct investigations that will lead to descriptions of relationships between evidence and explanations; and SC8.3.1.e Describe how plants and animals respond to environmental stimuli.

The lesson plan has an inquiry-based component, which is supported by the use of duckweed in scientific experiments. The first interaction with students starts with an introductory phase that includes an introduction of the science vocabulary that is going to be used throughout the project and a brief explanation of the outreach project’s goal. Consequently, the Duckweed Project instructor guides the students through a pre-planned class experiment set-up using duckweed, which served as a model for the students to develop their own experiment in the following classes. This is intended to further their learning of the objective and to reinforce their previous knowledge about the scientific method. On the second week, students analyzed the experiment’s results and discussed them in terms of experiment design and environmental relationships. After that, some of the students were asked to design their own new experiment with duckweed and another variable. On the third week, all the students set up their own experiments. Finally, on the fourth week, students analyzed their new results and interpreted them.

The Duckweed Project is taught one day per week in each classroom to four class sessions. Activities include hands-on, exploratory, collaborative, and analytical skill sets.

Table 1*.* *Overview.*

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| CLASS PERIOD | INQUIRY-BASED LESSON |
| 1 | -*Engagement* Activity: looking into fish tank with pond water to, list what they see and make predictions of possible interactions between biotic and abiotic components.  -Vocabulary introduction: duckweed and aphids |
|  | *Experimentation*  Set up Experiment 1 – Class (Guided by instructor)  Question: Is there an effect of aphids on duckweed (*Spirodela polirhyza*) growth? |
| 2 | *Explanation*  -Students collect results and interpret them, guided by instructor.  *Expansion*  -Students (groups) come up with a question, that involves duckweed and another variable, and design an experiment to answer it. |
| 3 | Student set up Experiment 2 in groups |
| 4 | Students collect results and interpret them, guided by instructor. |

*Experiment 1*

Supplies:

1. Cups to be used as “experimental units”. Any kind of plastic of Styrofoam cup should work. In general a cup with less steep sides works better as fewer duckweed get stranded as water evaporates. Clear plastic cups enable the students to see the roots and side, but it may also let in more side light leading to more algae growth.
2. Tray. Optional, but can prevent spills when transporting cups of duckweed
3. Duckweed. Gathered from a local source or ordered online.
4. Plastic loop, bamboo skewer, stick, toothpick, etc. Something which the students can use to easily move duckweed into cups. A good technique is to sweep under the duckweed, catching the root and the bottom of the frond.
5. Nutrient solution: Use Miracle Gro (24-8-16). The important thing to check is the N-P-K ratio on the side of the box. From my experience, the one labeled 24-8-16 is the one that DOES NOT say “Nursery Select”. The target concentration is 0.058g/L. You can achieve this by adding ¼ tsp of Miracle Gro to 5 gallons of water. For smaller amounts, you can dissolve ¼ tsp of Miracle Gro in 1 cup water, and then add 3 Tsp of that solution to 1 gallon of water. Either use distilled water or add chlorine binding drops as directed on the bottle. Some municipalities (including Lincoln, NE) use chloramine instead of chlorine gas to treat their water, so you can’t just let the water sit out, you need to use chlorine drops. You can get them at any fish supply store.
6. Light source. Either a window or shop lights. A pair of 40W fluorescent bulbs in an inexpensive shop light can be placed 6-12 inches from the duckweed. You can build a simple PVC stand, or hang the lights from a shelf. Again, randomize order under the lights.
7. Treatment. We developed this using duckweed aphids, but you could use any treatment. For example, you could try a carbon dioxide treatment by covering all of the cups with plastic wrap. Then use a source of carbon dioxide, perhaps the soda making equipment they sell in stores, to push carbon dioxide into half of the cups.

Design:

How many cups?

In general, experiments always have more power to detect differences. In reality, you balance the number of cups against the time and space in the classroom. Be sure to have enough cups so that each group of students are setting up both the control and the treatment.

1. Label the cups
2. Add prepared nutrient solution to a set level in the cup
3. Decide as a class how many initial duckweed to add. I recommend about 12-16 if you want to look at something that effects growth. Note, duckweed are counted by counting each individual frond. Fronds are often found in clusters of 3-4. The biggest mistake people make is counting clusters instead of fronds. Diagram this beforehand and have people check each other’s work. Record how many duckweed are added to each cup.
4. Apply the treatment to half the cups. Do this in at least a haphazard order if not a formally random order. If you apply the treatment to the first half of the cups and the control to the second half, there might be bias in the experiment. It is possible you picked out bigger, healthier fronds for the first cups as compared to the latter cups.
5. Set the duckweed up by a window or under a set of fluorescent lights. Do not clump the treatments together, as students often want to do, because this can create hidden bias. For example, the light might be brighter on one side of the bench.
6. If the room is dry, you may want to add distilled water to each of the cups after 3-4 days to bring them back up to the original volume. The water evaporates, not the nutrients, so just add back in the water.
7. Seven days later, count size of the population in each cup. Plot the differences. Examine the average differences.

*Optional addition to Lesson Plan:* Have students read about previous student experiments at <http://duckweed.unl.edu>. This could be down before students design their own experiements in period 2. That may hinder their creativity, so instead they could look at papers after they come up with their initial idea. In reality, different scientists do this at different times.

Students could write reports from their experiment 2 results and post them in the Duckweed Paper Exchange at <http://duckweed.unl.edu>. Contact Chad Brassil [cbrassil@unl.edu](mailto:cbrassil@unl.edu) to have a free account setup for your class.