Lesson Plan, HTH Biology, Upper School

Submitted by: Andrea Cook
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School: High Tech High
Date: December 10, 2001

Grade level: 10,11
Subject: Biology
Duration: 6 weeks

Description: This lesson can be used as a detailed introduction to experimental design. It sets the foundation for making scientific experiments the focus of collaborative project work in biology.

Goals: Students will learn the basic elements of an experiment, and experience what it is like to design an experiment of personal interest and try to conduct it as a group project.

Objectives:

1. students will be able to turn everyday observations into testable questions (put observations in perspective, make connections to what they already know, determine relevance to others and what others already know)
2. students will conduct experiments as a way of gathering data to answer questions (gather evidence)
3. students will evaluate data to determine if a hypothesis has been supported or not (use evidence to support reasoning)
4. students will apply what they learn to new circumstances (supposition)

Materials:

Experimental design handouts

Vocabulary:
Quantitative data, descriptive data, hypothesis, independent variable, dependent variable, standardized variables, control, replication, method, budget, data table.

Procedure:
1. have students make observations in school yard, ask questions about the school yard, and wonder how nature works out there
2. discuss what makes a question testable, and feasible to test
3. discuss with students how their ideas might be turned into experiments, work through a few examples with them, using their ideas
4. have students learn necessary vocabulary through readings, discussions, practice problems, and designing simple experiments by themselves

5. get students into groups by interest, have them design an experiment that they as a group would like to try to conduct
6. have the students write a formal proposal of what they would like to do and have them orally present their plan to the class
7. have the class question the meaning, feasibility, the method, of the experiment in an attempt to make the experimental plan as good as possible prior to proceeding
8. have the students conduct the experiment
9. have the students report what happened during the experiment in formal written and oral formats
10. have the students reflect on what they learned

Assessment:

Embedded in the learning. Daily opening writings. Daily closing reflections. One quiz on vocabulary (10 points). One test on applying vocabulary in given experiments, and designing own experiment (50 points). Two written proposals (20 points), two oral presentations (10), and one personal reflection on the process of learning to design and conduct experiments (10 points). 100 points total.

Chief Scientist – A D
Materials Manager – J A
Scientific Illustrator – N S
Scientific Writer – A D
Data Manager – K E
Date: 2/4/02
Block: C

Water Group Proposal

Observation:	The three treatment ponds at the Slough seem to have the job of filtering the water that goes into Mission Bay.
Question:	What tests can we do to determine whether the treatment ponds are doing their job to filter the urban runoff that goes into the Slough and eventually into Mission Bay.
Hypothesis:	We can test whether the treatment ponds filter the water (urban runoff) coming from the neighborhood streets by taking samples of the pH of the water in the three ponds.
Dependent: Variable	pH of water, maybe nitrate if we have time
Independent: Variable	location of water
Control:	faucet, street (from the neighborhood), and ocean water
Standardized: Variables	amount of water in each vial tools used throughout testing time of sample taking
Replication:	the number of times we take the water samples in the same location

Brief Explanation: We found a device that can give us a numerical reading of the pH in our water samples. Before we start our big experiment we want compare the pH results we get from faucet, street, and ocean water and the pH we get from putting fertilizer in faucet, street, and ocean water. This helps us see how much effect the fertilizer has on pH because the water that flows into the treatment ponds is street water and that already contains fertilizer which can change variables in the ponds by overgrowing plants and algae and killing organisms. We will then use the pH of the faucet and street water as our control to the pH of the water in the first, second and third ponds. We will organize our results and repeat the experiment another ten times. We use ten as our number of repeating the experiment because depending on what day we go there we might get varying results. If we have time left we would very much like to test the nitrate of the water in the three treatment ponds.

Predictions: We think that the water coming from the neighborhood going into the first pond will have a pH of 7.5 or 8.0 because it is fresh water and we think fresh water is base. As the ponds do their job of filtering the water and its contents, the pH should drop between each pond reaching to a 7.0 or 6.5 by the time it reaches the Slough.

Method:

1. Using a numerical pH tester we will record the pH of faucet, street, and ocean water before and after we add fertilizer to them.
2. We will then use the pH of faucet and street water as our control.
3. We will test the pH of the water in all three treatment ponds.
4. We will repeat the experiment another ten times.

Data Table:

Location of water	Ph 1	Ph 2	Ph 3	Ph 4	Ph 5	Ph 6	Ph 7	Ph 8	Ph 9	Ph 10
Faucet										
Street										
Ocean										
Pond 1										
Pond 2										
Pond 3										

Materials:

At least 5 vials
A numerical pH meter
Paper
Pencil
Clipboard
No costs to HTH

Block B

Biology

Famosa Slough Project Reflection

Over the past twelve weeks, I have been leading four projects in my biology class. The main focus of these projects was a place called the Famosa Slough, which I will explain in more detail later. These projects ranged from heavy metal testing, to E.coli culturing. Although with such a wide range in ideas, these projects all had one thing in common, and that was to see what effect something was having at the Famosa Slough. We as a class encountered many difficulties, and "roadblocks" along the course of these projects, and I myself, as the class project leader, encountered many as well.

The Famosa Slough is a wetland that was at one point part of Mission Bay in San Diego, California. Though over development may have nearly completely obliterated this quickly deteriorating and scarce form of habitat, there are many efforts that are currently underway, and even more that are still in the planning stages, to keep this wetland alive. Although there might have been major ecological damage done to the Slough, such as an attempt to fill it as to make more land on which to build, or the ongoing urban threat (such as litter, or urban runoff from storm drains and roads), as well as the relatively frequent sewage leaks, and many other threats to this habitats well being. This habitat is a vital part of the eco system, and must be preserved as to safeguard our ecosystem. The Slough has many natural functions when it is healthy, such as a natural "filter", that which stops floods, as well as a home for countless life forms. Most of the experiments we are doing have never been done before, by anyone, so the work that we are doing now is truly helpful in understanding how we can help keep the Slough "alive".

There are a total of four projects that I am directing, these projects are, Heavy Metal Testing, pH Level Testing, E.coli Culturing, and Household Chemical Testing. Heavy Metal Testing is the group that I started, thus had more influence in than any other group I was working with. The Heavy Metals group is testing what heavy metals are present at the Slough, and what their concentrations are, then comparing the numbers that we find to the same heavy metals from the numbers of the San Diego Bay. The metals we are testing are copper, lead, zinc, and mercury, because they are some of the most common, and most volatile. Next, the pH Level Testing group is testing the different levels of pH near the treatment ponds to see if the ponds are in any way neutralizing the water running into the Slough. In essence, this group is trying to see if the treatment ponds are working. The E.coli Culturing group is also doing a test to see if the ponds are working, by testing the E.coli levels in and around the ponds to see if they are effectively lowering the amount of E.coli present. Lastly, the Household Chemical Testing group is doing an experiment to see how household chemicals effect plant life at the Slough, by taking grass, and exposing it to different household chemicals, then monitoring its change. With such diverse projects, there were many management difficulties.

As I said, with such a wide range of projects, it was difficult to manage the class. When one group is trying to find someone who is willing to run samples for them, another is trying to get test kits to run their own samples. A few problems that the Heavy Metals Testing group ran into were finding someone who was willing to run the costly samples for us, finding kits to run them ourselves, and figuring out the best way to take samples, as well as storing them correctly. First, I went online, and tried to find out how much it would cost if we just wanted to bite the bullet and pay for samples. It turns out that it costs upwards of $50-$100 per sample, so that was out of the question. Next we tried to find someone who was willing to either give us some form of sponsorship, and pay for the samples for us, or someone who had a lab, and was willing to run them. While we were doing this, the other Heavy Metals group for block A decided to get test kits, as to try and run the samples themselves. This proved to be a vain effort, because even after they had found samples, and even after they had them shipped to us, upon opening the packages, there was a key element missing, the impregnated test paper. So with self testing, it being quite farfetched that someone would pay the money to run our tests for us, and paying for a lab ourselves was out of the question, our only option was to get someone to run them for us. After hours of searching the internet for a lab in San Diego that was willing to run our samples for us at no charge, and countless e-mails, we were given a name by our teacher, Andrea Cook. Dr. Rick Gersberg was the one who would either make, or break us. Andrea coordinated for him to one day come in, and sit in on our class to watch us present our project idea. After a half hour presentation, he agreed to run our samples, and there was much rejoicing. We finally had solid ground to stand on. We had already taken samples, and went out on the field, and took more. We are currently awaiting Dr. Gersberg's return to give him the samples, and are anxiously waiting to see what will show up.

Halfway through this project, everything feels like it is coming together, and most all the groups seem to be gathering momentum as we reach this halfway point. There is something to show, and our evidence will only grow from here. All the hard work is materializing, and we are getting some concrete evidence, which we can start making assumptions from. Though there were a few "bumps in the road" at the beginning, it all seems to be smoothing out, and now the groups must start looking at their samples, and start piecing together results. All seems to be going well, and I hope that this trend of success continues.

Grades:

Plant Group (Household Chemicals) – B

I feel as though the group did a good job, but at times they didn't make the best use of their time.

Heavy Metals – A

This group did very well, utilizing the resources at hand, and is progressing impressively.

E.coli - A

This group is doing very well, they are getting results, and seems to be ready for a second set of tests.

pH Group – B +

This group is doing well, though are facing the same distraction issues (particularly in the great room) as the Household Chemicals group.

HTH Upper School Biology Showcase, April 1st 2002
Applying Biology to Help the Community: Student Research at the
Famosa Slough *(a local wetland)*

***Presenting:** all 35 students in Dr. Andrea Cook's three biology classes (Blocks A,B, and D)*

5:00 Welcome (Dr. Andrea Cook)

5:02 Introduction to the Famosa Slough and the HTH Famosa Slough Website
(Zak Zelin and Andrew Nho, class leaders and website designers)

5:05 Heavy Metals. What are they and why are they important?
(Dominick Pirela and Zak Zelin, chief heavy metals scientists

Block A — What are the heavy metal concentrations in the Famosa Slough and how do they compare with concentrations in Mission Bay and San Diego Bay?
(Dominick Pirela, Ryan Frazier, Starr Kirkland, David Kunugi, Devere Locke)

Block B — The above question…plus…Do the treatment ponds help to remove heavy metals from storm water before it enters the slough?
(Zak Zelin, Justin Appel, John Coleman)

5:20 Questions from panelists (only).

5:25 pH. What is it and why is it important?
(covered during the group presentation by Kyle Ellis)

Do the treatment ponds alter the pH of storm water before it enters the slough?
(Andy Dervishi, Jason Adame, Kyle Ellis, Nancy Sinong)

5:35 Questions from panelists (only).

5:40 Environmental Sedimentology: What is it and why is it important?
(covered during the group presentation by Stefan Englert)

What is the fate of trash that enters the slough?
(Stefan Englert, Matt Chadwick, Andrew Nho)

5:50 Questions from panelists (only).

5:55 Break (very short, 5 minutes)

6:00 E. coli. What is it and why is it important?
(Kira Sandage, chief E.coli scientist, Block B)

Block A — Mapping the concentration of E. coli in the Famosa Slough.
(Rory Ball, Tom Cosolito, Eddie Moreno, Winston Poon)

Block D — Are the treatment ponds effective in removing E. coli from storm water before it enters the slough?
(Michelle Gutierrez, Raphael Ilagan, Anabel Manuel, Brandon Thompson)

Block B — Are all E. coli measurements the same? Do concentrations vary within each of the treatment ponds?
(Kira Sandage, Izzy Ballesta, Iyan Sandri)

Next steps in the E.coli projects *(Michelle Gutierrez and Iyan Sandri)*

6:20 Questions from panelists (only).

6:25 Native Plants. What are they and why are they important?
(Ariane Salvador, chief plant scientist, D block)

Block D — How might soap in storm water runoff effect the germination of native plant seeds?
(Ariane Salvador, Elva Perez, Ehab Rahman, Moses Rodriguez, Thai Cao)

Block B — How might soap in storm water runoff effects native plants currently growing at the slough?
(Laura Madruga and Nick Zimmer)

Block A — Re-vegetation on non-native soil. How does species composition change after the original soil has been altered/disturbed?
(Jose Barajas and Lance Daschle)

6:45 Questions from panelists (only).

6:50 Closing Remarks *(Andrea Cook)*
Invitation for questions from anyone to any of the student presenters.

Group Presenting_______________ Evaluator's name_________________

Presentation Assessment
Upper School Biology - High Tech High

	Poor	Developing	Good	Great	Exemplary
Knowledge	0	1	2	3	4

- The students showed good understanding of the topic being covered.
- Basic biological facts (on pH, E.coli, etc.) were provided.
- Students were able to put their project into a larger context.
- Students did not exclude any important information or include any unnecessary information.

Experimental Design	0	1	2	3	4

- The research problem/ hypothesis was clearly stated.
- The research "proposal" was discussed/acknowledged/outlined (before going to the field, students worked very hard to write complete research proposals and an abstract summarizing what they hoped to accomplish by doing their project...did they explain their proposal and express their hopes?)
- The methods (proposed and/or actual) were clearly outlined/explained.

Process/ Field Experiences	0	1	2	3	4

- The students conveyed what they did/accomplished/discovered when they went to the Famosa Slough to carry the research they had planned.
- Students shared realizations that they came to in the process of trying to do their research (i.e. E.coli can't be counted or identified under the microscope, growing native plant seeds isn't as easy as it sounds).
- Students demonstrated progress in developing their method/carrying out their research plan (at this stage in the scientific process, students are not expected to have conclusive data or final results).

Data	0	1	2	3	4

- Students clearly state the type of data they are seeking to collect (i.e. germination rates, number of E.coli per milliliter of water).
- Students discussed any data they did collect, and the validity of that data.

	Poor	Developing	Good	Great	Exemplary
Looking Forward	**0**	**1**	**2**	**3**	**4**

- Students clearly articulated what their next steps in the project would be.
- Students acknowledged the people/adults who helped them on their projects.

Participation	**0**	**1**	**2**	**3**	**4**

- Each student did their "fair share" of presenting.
- All students were engaged in their project/presentation.
- Participation was well coordinated, and students worked well in teams.
- Students answered questions cooperatively and effectively.

Design	**0**	**1**	**2**	**3**	**4**

- Presentation was creative, very easy to see and follow, and did not include any unnecessary graphics. Students made good use of visuals.

Presentation Style	**0**	**1**	**2**	**3**	**4**

- Good eye contact. Strong voices. Nice transitions. Appropriate body language. Expressive. Thoughtful. Enthusiastic.

Other feedback

What constructive criticism can you provide for improving this project?

List 3 positive things about this project and presentation.