3rd-5th Grade (upper elementary)

Lesson 4: Doing scientific inquiry in local ecosystems

(a) To provide students with an opportunity to participate in scientific inquiry by investigating the water quality at 5 sites: school, filtered water from teacher's house, Pinto Lake, Corralitos Creek, and the Pajaro River.

(b) This project is linked to Melissa Miller (a senior wildlife veterinarian at the Department of Fish and Wildlife) and her discovery of the cause-effect relationship between freshwater blue-green algae at Pinto Lake (a recreational lake frequented by students and their families) and several sea otter deaths along the Central California Coast. This will serve as an excellent example to demonstrate how inland areas (Pinto Lake) are connected to the bay (Monterey Bay) through the watershed, i.e., Pinto Lake→ Corralitos Creek→ Pajaro River→ Monterey Bay.

Purpose: The purpose of this lesson is two-fold: (a) to provide a real life experience of '*doing scientific inquiry*' which is focused on a local issue; and (b) to provide an opportunity for students to share their results with an expert scientist (Activity 1) Melissa Miller.

Key concepts: science, inquiry, scientific inquiry, nitrates, phosphates, bacteria, pH, dissolved oxygen, temperature, fertilizer, ammonia, blue-green algae, Microcystis, Microcystin, toxins, contamination, pollution, decomposition, etc.

Research based: Sociocultural theory with an emphasis on co-constructing knowledge and negotiating meaning using **Wells (1999, 2002, 2010) model, 'Spiral of learning and teaching through inquiry'**.

Materials: Scientific inquiry template books, water quality kit, pencils, erasers, gloves, posters, and markers.

Common Core Standards:

English Language Arts Standards:

Reading Informational Text:

Key Ideas and Details:

CCSS.ELA-Literacy.RI.3.3 (third) Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

CCSS.ELA-Literacy.RI.4.3 (fourth) Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

CCSS.ELA-Literacy.RI.5.3 (fifth) Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

Craft and Structure:
CCSS.ELA-Literacy.RI.3.4 (third), 4.4 (fourth), and 5.4 (fifth) Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3-5 topic or subject area.
CCSS.ELA-Literacy.RI.3.5 (third) Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently.

Integration of Knowledge and Ideas:
CCSS.ELA-Literacy.RI.3.7 (third) Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).
CCSS.ELA-Literacy.RI.3.8 (third) Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).
CCSS.ELA-Literacy.RI.4.7 (fourth) Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
CCSS.ELA-Literacy.RI.4.8 (fourth) Explain how an author uses reasons and evidence to support particular points in a text.
CCSS.ELA-Literacy.RI.5.7 (fifth) Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
CCSS.ELA-Literacy.RI.5.8 (fifth) Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).

Writing:

Research to Build and Present Knowledge:
CCSS.ELA-Literacy.W.3.7 (third) Conduct short research projects that build knowledge about a topic.
CCSS.ELA-Literacy.W.4.7 (fourth) Conduct short research projects that build knowledge through investigation of different aspects of a topic.
CCSS.ELA-Literacy.W.5.7 (fifth) Conduct short research projects that use several sources to build through investigation of different aspects of a topic.

Mathematics Standards:

Measurement and Data:
- Represent and interpret data (third, fourth, and fifth).

Mathematical Practices:
- Reason abstractly and quantitatively (third, fourth, and fifth).
- Construct viable arguments and critique the reasoning of others (third, fourth, and fifth).

Next Generation Science Standards (NGSS):

Disciplinary Core Idea Progression:

Earth Space Science Progression (ESS2.E): Living things can affect the physical characteristics of their environment.

Earth Space Science Progression (ESS3.C): Societal activities have had major effects on the land, ocean, atmosphere, and even outer space. Societal activities can also help protect Earth's resources and environments.

NGSS Science and Engineering Practices:

Asking Questions and Defining Problems:

- ***Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.***

Planning and Carrying Out Investigations:

- ***Evaluate appropriate methods and/or tools for collecting data.***
- ***Make observations and/or measurements to produce data to serve the basis for evidence for an explanation of a phenomenon or test a design solution.***

Analyzing and Interpreting Data:

- ***Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.***
- ***Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.***
- ***Compare and contrast data collected by different groups in order to discuss similarities and differences in findings.***

Constructing Explanations and Designing Solutions:

- ***Construct and explanation of observed relationships.***
- ***Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.***
- ***Identify the evidence that supports particular points in an explanation.***

Engaging in Argument from Evidence:

- ***Compare and refine arguments based on an evaluation of the evidence presented.***
- ***Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.***
- ***Respectfully provide and receive critiques from peers about a proposed procedure, explanation or model by citing relevant evidence and posing specific questions.***
- ***Construct and/or support an argument with evidence, data, and/or a model.***
- ***Use data to evaluate claims about cause and effect.***

Obtaining, Evaluating and Communicating Information:

- ***Obtain and combine information from books and/or other media to explain phenomena or solutions to a design problem.***
- ***Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.***

Procedure:
Wells' model, "Spiral of learning and teaching through inquiry," in action:

I. Tapping into students' prior knowledge and experiences:

Pre-assessment: (Use pdf) [Note: The pre and post-assessments are assessing understanding of the scientific inquiry process in addition to students' attitudes (perceptions) about '*doing science*'.]

1. What does it mean to '*do science*'?
2. What do scientists do?
3. What are your thoughts/feelings about science?
4. When you think about a scientist, what image comes to your mind?
5. Do you think you can do science? Explain your answer.

Use the pre-assessment questions to tap into students' prior knowledge and experience about engaging in the scientific inquiry process of investigating the water quality at 5 locations. Allow students time to share their knowledge and experiences in pairs, small groups, and whole class. Both you and the students can review the **scientific inquiry template books** (after the pre-assessment) to scaffold each step of the inquiry process. This also provides an opportunity to discuss key concepts within the context of the book.

II. Gathering information:

Students can seek information from the teacher (**articles and video**) and Internet about Melissa Miller's discovery of how blue-green algae from Pinto Lake flowed through the Pajaro watershed: Corralitos Creek, the Pajaro River, and Pacific Ocean, which resulted in the death of several sea otters. Microcystin is a toxin released from blue-green algae. This toxin contaminated the shellfish which the sea otters eat, thus resulting in fatal liver damage. Students' mission is to investigate whether these sites have additional contaminates such as nitrates, phosphates, bacteria, etc. Note: Your class may not reside along the Central California Coast, thus you can choose a different environmental issue to focus on. If you need a scientific inquiry template book designed for the local environmental issue your class is investigating, please contact the curriculum designer (Lisa M. Algee at lisa.algee@mongabay.com) and she can assist you.

III: Co-constructing knowledge together:

Allow students time to learn about what a watershed is, in this specific case, we as a class are starting at the source of the problem (Pinto Lake). We will first test the water at (a) Pinto Lake, (b) Corralitos Creek, (c) Pajaro River), (d) school (as a control), and (e) filtered water, also as a control. As a class, explore Google maps to get a visual image of how the watershed flows (starting at Pinto Lake and ending with the Pajaro River flowing into the Pacific Ocean).

IV. Understanding

Demonstrating understanding through post-assessment and activities (see activities**):**

Post-assessment: (Use pdf)

1. What does it mean to '*do science*'?
2. What do scientists do?
3. What are your thoughts/feelings about science?
4. When you think about a scientist, what image comes to your mind?
5. Do you think you can do science? Explain your answer.