**Subject area/course**: Science/Environmental Science

**Grade level/band**: 9-12

**Task source**: Summit Public Schools

**Ecocolumn**

**TEACHER'S GUIDE**

1. **Task overview**:

For this project, students will first build and study a functioning, semi-closed ecosystem. They will model this ecosystem using diagrams. They will collect, organize, and interpret data about how the ecosystem changes over time. Lastly, they will develop a testable question, hypothesis, and proposed study to build from their data. This project culminates in two final products: a "pitch" for funding for their proposed follow-up study; and an optional graded FRQ that draws on content and skills developed during the project.

1. **Aligned standards:**
2. **Primary Common Core State Standards**

[CCSS.ELA-Literacy.WHST.9-10.7](http://www.corestandards.org/ELA-Literacy/WHST/9-10/7/) Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

[CCSS.ELA-LITERACY.WHST.9-10.4](http://www.corestandards.org/ELA-Literacy/WHST/9-10/4/) Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

1. **Secondary Com****mon Core State Standards**

[CCSS.ELA-LITERACY.WHST.9-10.9](http://www.corestandards.org/ELA-Literacy/WHST/9-10/9/) Draw evidence from informational texts to support analysis, reflection, and research.

1. **Critical abilities**

Research: Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience.

Analysis of Information**:** Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Modeling, Design, and Problem Solving:Use quantitative reasoning to solve problems arising in everyday life, society, and the workplace, e.g., to plan a school event or analyze a problem in the community, to solve a design problem or to examine relationships among quantities of interest. Plan solution pathways, monitoring and evaluating progress and changing course if necessary, and find relevant external resources, such as experimental and modeling tools, to solve problems. Interpret and evaluate results in the context of the situation and improve the model or design as needed.

1. **Next Generation Science Standards**

**Developing and Using Models**

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

* Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2),(HS- PS3-5)

 **Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

* Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4)

**Systems and System Models**

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2), (HS-LS1-4)

**Energy and Matter**

* Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6)
* Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)
1. **Time/schedule requirements:**

The following schedule is an estimated timeline for this task. The entire task will take approximately **2-3 weeks**. Time requirements will vary based on grade level, schedule constraints, class size, class length, and academic readiness.

* Step 1. Introduction & Build Ecocolumn – Abiotic & Plants – Days 1-2
* Step 2. Build Ecocolumn – Animals & Begin Data Collection – Days 3-5
* Step 3. Create a Model – Days 5-7
* Step 4. Determine a Testable Question – Days 8-9
* Step 5. Hypothesis & Study Design – Dasy 10-11
* Step 6. Report & Proposal – Days 12-15
* Step 7. In Class FRQ (OPTIONAL) – Day 15 or 16
1. **Materials/resources:**

Documents:

* Item A. Building an Ecocolumn Student Instructions
* Item B. Adding Organisms
* Item C. Terrestrial Animals List
* Item D. Data Collection Setup
* Item E. Nitrogen Cycle Task Card
* Item F. Natural Biogeochemical Cycle Model Feedback
* Item G. Asking a Testable Question
* Item H. Examples of Testable Questions
* Item I. Hypothesis and Experiment Design
* Item J. Ecocolumn Report and Proposal
* Item K. Breaking Down an FRQ Prompt (optional)
* Item L. Ecocolumn FRQs (optional)

For the Ecocolumn:

* Soil
* Aquarium Gravel
* Small cups or gardening spades (to scoop gravel and soil)
* 2L Clean, Clear (NOT GREEN) Bottles (2 per group, plus extra for mistakes)
* Clear packing tape
* Large masking tape
* Twine
* Aquarium plants (Elodea and/or duckweed)
* Sprouted plants (1 per group, plus extra for mistakes)
* Seeds
* Small fish
* [Water conditioner](http://www.petsmart.com/fish/water-care-conditioning/api-stress-coat-tap-water-aquarium-conditioner-zid36-17508/cat-36-catid-300006;pgid=3jh0cDFn5R5SRpeGkJSCB38m0000m0sRO2q9;sid=I1ZzkfQnnBZ0kaA_XhAylcQtZiokgxcsf_Bt2LKC?var_id=36-17508&_t=pfm%3Dcategory) (the kind that removes chlorine)
* Probeware (CO2 gas, DO, O2 gas, Nitrate, pH, temperature)
* Distilled water
* Rinse bottles
* Rinse basin
* Clean plate to set unused probeware on
* A Few Nickles (to keep the storage solution from spilling)
* A drill OR Hammer + Nail
* A cooler of water or spring water (if you don’t have sink access)
* Scissors
* Box cutters
1. **Prior knowledge:**

None listed.

1. **Connection to curriculum:**

None listed.

1. **Teacher instructions:**

Step 1:

* Have students form groups of 3-4 and review the *Building an Ecocolumn Student Instructions* document (Item A).
* Students should put together abiotic features of Ecocolumn and add plants, then make a plan for animals.

Step 2:

* Students add biotic components to their Ecocolumns, using the instructions in Item B, *Adding Organisms*, and the list of organisms in Item C, *Terrestrial Animals List*.
* Students complete *Adding Organisms* document to record how many of each kind of organism is now inside their Ecocolumn.
* Ecocolumns are officially taped closed.
* Students make copy of data table for their group.
* Students complete the *Data Collection Setup* activity (Item D).

Step 3:

* Students complete the *Nitrogen Cycle Task Card* (Item E) and begin to create models of their Ecocolumns.
* Use the *Model Feedback* form (Item F) to facilitate a peer review session.

Step 4:

* Students create a testable question, and then receive feedback from peers regarding their question and data.
* Use the documents *Asking a Testable Question* (Item G) and *Examples of Testable Questions* (Item H), if desired.

Step 5:

* Students establish a hypothesis and design a controlled experiment that will test the hypothesis and address their question (Item I).

Step 6:

* Next, students will write a grant proposal to receive funding for their project from the National Science Foundation. See Item J for student instructions.

Step 7 (Optional):

* If students are not familiar with FRQs (free response questions), use Item K, *Breaking Down an FRQ Prompt*, to introduce and explain the expectations of FRQs.
* During one class period, students should complete Item L, *Ecocolumn FRQs*, individually.
1. **Student support:**
* Students may need support in developing their hypothesis and experiment. It may be helpful to go through examples of experiments, especially how to identify the independent and dependent variables and the control group.
* Writing the grant proposal will be a daunting task for some students. If needed, provide paragraph frames for ELL and SPED students. Opportunities for peer review will also be helpful in writing the proposal.
1. **Extensions or variations:**

The teacher should decide if he/she would like to include the FRQ as a component of this task. The grant proposal could be completed individually or in groups. If completed in groups, the FRQ could be used to assess students individually.

1. **Scoring:**

Student work can be scored using the Summit Public Schools Ecocolumn rubric.