CHAPTER 15

Activity 8: Saving the World—One Ecosystem at a Time

Biology: Ecosystems and Biological Diversity

Maintaining biodiversity within a healthy ecosystem is critical. What goes on in an ecosystem that makes it function?

In this activity, teams of students get an opportunity to research an ecosystem and design a solution to maintain the health of ecosystem services. Teams will evaluate the merits and the constraints of each solution and present oral arguments defending their solutions.

Safety First

In every activity, we remind you to be certain that you understand the potential risks involved and are confident you can ensure your students' safety. Before attempting any of these activities in class, we recommend completing them yourself, and optimally with a teaching partner.

STEM

Designing a solution to a scientific problem is very much an engineering STEM activity. Students will use technology to find information to help them learn about the science of ecosystems and come up with a rank-order list of solutions.

Tying It to *NGSS*

Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (MS-LS2-5)

[Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

Science and Engineering Practices

Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)

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Disciplinary Core Ideas

Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)

LS4.D: Biodiversity and Humans

Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (Secondary to MS-LS2-5)

ETS1.B: Developing Possible Solutions

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (Secondary to MS-LS2-5)

Crosscutting Concepts

Stability and Change

Small changes in one part of a system might cause large changes in another part. (MS-LS2-4), (MS-LS2-5)

Tying It to *Common Core State Standards, ELA*

RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings and speculation in a text. (MS-LS2-5)

RI.8.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS-4), (MS-LS2-5)

Tying It to *Common Core State Standards, Mathematics*

MP.4 Model with mathematics. (MS-LS2-5)

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-LS2-5)

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Misconceptions

Misconceptions about ecosystems are as vast as the varieties of ecosystems! "Plants get their food from soil;" "The top of the food chain has the most energy because energy accumulates moving up the chain;" "Carnivores are ferocious and herbivores are passive;" there are far too many examples to list here. Instead, we refer you to this website—*http://ecomisconceptions.binghamton.edu/intro.htm*—for an extensive list of misconceptions.

There are also many websites that provide a range of explanations and accurate representations regarding ecosystems.

In addition to the NSTA Learning Center that offers substantial background information on ecosystems and habitats, for more on helping students break through scientific misconceptions, consider the resources developed by Dr. Philip Sadler and others associated with the Harvard-Smithsonian Center for Astrophysics: see "Minds of Our Own" and other free online resources and video resources at *http://www.learner.org/resources/series26.html*.

In each activity, we recommend Page Keeley's series about identifying the prior knowledge your students bring to your classroom: see *Uncovering Student Ideas in Science* (*http://uncoveringstudentideas.org*).

Objective

By the end of this activity, students will have demonstrated the abilty to research and then present an evidence-based argument proposing various solutions to maintaining biodiversity and equilibrium in an ecosystem to preserve the ecosystem services.

Note: The *NGSS* standard for this activity requires research and comparison of existing technologies. To add a hands-on, minds-on "warm-up," time permitting of course, we offer a companion activity in parallel here. However, while it will add relevance and increase understanding of the science and engineering practices in the main activity, it will not meet the standard by itself.

Companion Activity Objective

Students will be able to create, observe and report on an ecosystem of their choosing. Students might select an ecosystem in a jar covered with plastic, bacteria in a petri dish, a terrarium with a critter, and so on.

Academic Language

Ecosystem, diversity, water purification, nutrient recycling, soil erosion, food webs, vigor, organization, resilience, ecosystem services

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Focus Questions (Scientific Inquiry)

- How can the merits and constraints in maintaining diversity and health in an ecosystem be ranked?
- Why is diversity important in an ecosystem?
- Why is it important to preserve ecosystems even if people are not directly impacted by their degradation or destruction?
- What do you think an "ecosystem service" is? Can you give examples?
- How can ecosystem services be preserved?
- How do ecosystem services vary between different ecosystems?
- What are the economic implications of preserving ecosystems?
- What are the social considerations in preserving ecosystems?

Framing the Design Problem (Engineering Practice)

Students can pursue the following problem for this activity: "For each ecosystem targeted, design a solution to preserve the ecosystem services."

Refer to Figure 4.3 "The Engineering Design Process" (p. 45) for more information about how to frame the design problem for this activity.

Teacher Background

Biodiversity is the connection of living things to each other. Plants and animals that exist together in a particular area are said to live in an ecosystem (short for *ecological system*). These plants and animals interact with one another and with the nonliving elements of the area, such as climate, water, and soil. Ecosystems can be as small as the space under a log or as vast as the entire forest. Ecosystems are generally described in terms of the "services" they provide. Visit the National Wildlife Federation (*www.nwf.org*) for more background information regarding provisioning and regulating the cultural and supporting services of ecosystems.

Companion Activity

For a good example of an ecosystem students can create, study, and then investigate protective solutions to apply, see this sample activity in which students construct a classroom coral reef biome: *www.bsu.edu/eft/ecosystems/p/activities.html*.

In this companion activity, students create and then interact in a coral reef environment they build in class to experience visiting a coral reef and learn about ecosystem interdependence (i.e., roles of the reef inhabitants as producer, consumer, predator or

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prey, parasite or host, and other relationships that are mutually beneficial or competitive). Students explore how the balance of a reef ecosystem can be disrupted by human activities, inviting them to consider solutions.

Preparation and Management

Locate visuals of various ecosystems, aquatic as well as terrestrial, on the internet. Put visuals on PowerPoint slides to project—this helps engage students and bring alive different types of ecosystems (many of which your students may not identify as ecosystems per se).

Prep Time

60 minutes to locate internet visuals

Teaching Time

Three 45-minute class periods

Materials

- Internet visuals of ecosystems
- Whiteboard and markers for each group
- Student notebooks
- Access to internet and online resources
- (For the companion activity: student-collected materials for ecosystems, such as jars, plastic wrap, rocks, terrarium, and so on

5E Instructional Model

Engage

Invite students, seated in table groups, to watch slides of various ecosystems, with no prior discussion from the teacher. As each slide is projected, have groups discuss what they think they are seeing. At the end of the slides, ask students what all the slides had in common. Access students' prior knowledge by having them use their notebooks to make a list of their ideas about what a healthy ecosystem looks like and how they know it is healthy.

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Preassessment

Ask the students to answer these two questions:

- How might you measure the health of an ecosystem?
- In what ways can humans have a positive effect on an ecosystem?

These sorts of questions—whether presented as writing prompts, table group starters, or in another small group discussion format—will help you gauge student prior knowledge regarding ecosystems. You can also consider their ability to support their ideas with evidence and details to determine their level of argumentation skill as you plan the rest of the activity and subsequent lessons on this topic.

Explore

In a whole-group brainstorm, make a list of all ecosystems students can think of: forest, desert, grasslands, mountain, aquatic (and the many sub-ecosystems). Leave space between each ecosystem so that students can sign up to investigate that ecosystem.

Let students sign up for the system they want to investigate, with no more than three students in each group. Students should record their ecosystems and group members in their notebooks.

Next, students need to work with their group members to do the following:

1. Brainstorm and research all the ways in which their ecosystem maintains its health. Students should look at the rigor, organization, and resilience of their system as well as the ecosystem services.
2. Make charts in their notebooks in preparation for their solutions. Students should chart their own ecosystem, identifying strengths, weaknesses, solutions, and so on (see example chart).
3. Students fill in their charts as they research solutions. Remind them to use the academic language for this activity.
4. Students discuss and then rank their solutions, with "1" being the most important solution to maintain the ecosystem services.
5. Students then transfer their notebook work to a whiteboard and discuss their plans to share orally with the full class.

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Example: Coral Reef Ecosystem

Solution for Maintaining Health	Merits	Constraints (scientific, economic, and social considerations)	Ranking and Reasoning (lowest number = most important to do first)
Spectrographic imager	Takes pictures of coral from airplane for data comparison; can assess quickly	Expensive	
Predator-prey monitoring	Balance needed for health of ecosystem	Difficult to control and introduce species	
Coastal zone management	Control amount of development and industrial run-off	Cost of regulating	
SCUBA divers and snorkelers	Ecosystem service: cultural	Need to control and educate about coral reef care when diving. Hard to regulate diver activities.	

Explain

Student groups present their ecosystems and whiteboards, one at a time, to the rest of the class. The teacher invites other students to ask questions about the group's rankings. Be sure to apply the academic language in context as students explain their solutions.

Elaborate

Each group takes their top-ranked idea from their chart and draws a "to scale" diagram depicting their idea.

Evaluate

Students should write their explanation of the process they went through to rank-order their solutions.

Discussion and Argumentation

When students present their ecosystems and whiteboards, the class can ask questions and challenge their research findings and solutions, requiring the presenters to cite their evidence and sources.

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Differentiation

1. **Broader Access Activity:** Provide access to a variety of types and levels of research materials, the internet, current magazines, and so on. Students should be taught how to find research from reliable sources. As you scaffold student research experiences, lower-achieving students might choose very simple information, while high-achieving students might choose to explore peer-reviewed research articles. The goal is for lower-achieving students to ultimately access the higher-quality research publications.
2. **Extension Activity:** Students can identify and research a local ecosystem in their city or area and complete a chart similar to the one done in their group. Ideally, students could use the chart to educate peers, make a public service announcement, or present their findings to relevant school or community leaders.
3. **Modified Assessment:** Allow students to demonstrate their understanding in verbal explanations or labeled drawings rather than the written process statements.
4. **Challenge Assessment:** Students can add a concept map of their ecosystem and various solutions, drawing arrows to show their interconnectedness.

Note: These are examples as illustrations of possible differentiation options. The actual adaptations you create will depend on the results of your preassessment and ongoing formative assessments of individual students.

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