Iowa Science Teachers Journal

Volume 36 | Number 1 Article 5

2009

Weaving the Web of Inquiry: An Activity Introducing Students to Marine Food Webs

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WEAVING THE WEB OF INQUIRY

AN ACTIVITY INTRODUCING STUDENTS TO MARINE FOOD WEBS

Kelp photo by Kait Curran Palmer; Coral photo by Claudia Meyer
Algae photo by Kriss Szkurlatowski; Urchin photo by Malina
Clam photo by Josep Altarriba; Graphics work by Joe Taylor

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ABSTRACT: This activity engages students in a biological investigation focusing on marine life. Students receive pictures of several marine organisms, make observations, and propose a possible food web which includes each of the organisms. Students also explain to the class their rationale behind the construction of their food web. This activity promotes increased familiarity with food webs, ecosystems, and energy flow. While this activity focuses on marine life, the activities and strategies could be used with most any ecosystem of interest. *This activity promotes National Science Education Standards A, C, F and G , and Iowa Teaching Standards 2, 3, 4, and 5.*

Iowa students have little opportunity to experience marine life. This activity encourages students to explore the diversity of marine life and the food hierarchies of the ocean. We describe strategies we implement to better promote our goals for students, reflect how students learn, promote an understanding of the nature of science, and incorporate National Science Education Standards. This activity could be used during units on predator-prey interactions, natural selection, evolution, ecology, and/or conservation.

Finding Pictures of Marine Life

In order to provide students with concrete representations of the marine life they will be studying, we focused on finding quality pictures of organisms from a variety of ocean biomes. We have seen similar activities that make use of cartoon-like drawings of marine organisms. We discourage this approach. While drawings might be perceived as more fun, we have found that using actual photos is more beneficial to students because they provide representations of the organisms that are more concrete than drawings. By starting the lesson with concrete representations you will be in a position to later scaffold to more abstract concepts and ideas. A progression from concrete to abstract will reach far more students than if only focusing on abstract ideas (Woolfolk, 2004).

Prior to the lesson you will need to make up sets of marine organism flashcards. Students will use these picture cards to make observations of the organisms and create their food webs. With such immense marine diversity located in our oceans, you have almost limitless choices of what biomes and groups of organisms to include with each set of flashcards. We recommend several Internet resources with information of marine organisms to help you get started in making your own class set of flashcards:

TIPS FOR MAKING FLASHCARDS

- Wrap each flashcard in packing tape for better durability
- Create enough sets of flashcards so that students can form into groups of 2-3.
- Create one set of flashcards with magnets fastened to the back so they can be stuck to a board at the front of the classroom during discussions

http://www.marinespecies.org/
http://nlbif.eti.uva.nl/bis/index.php
http://www.marinefauna-cebu.com/list.html
http://oceanworld.tamu.edu/resources/oceanography-book/marinefoodwebs.htm

Engaging Students: Food Chains to Food Webs

Before handing out the flashcards, a quick discussion about food webs may be necessary as students may not clearly understand how to construct a food web. Our experience with secondary students has been that students are familiar with food chains, but not food webs. We engage students in discussing food webs by drawing a familiar food chain on the board. For example, "Grass - Rabbit - Coyote - Mountain Lion". Students quickly realize that the words represent a food chain and we lead students toward food webs by asking,

- "What is missing from this kind of representation?"
- "To what extent does this food chain represent all of the relationships within an ecosystem?"
- "What else, other than coyotes, might a mountain lion eat?"

Based on student responses the class can begin constructing a food web. Asking students questions like "How does a food web better represent nature than a food chain?" can encourage students to think more deeply about the relationships among organisms. Using animals with which students are familiar helps students more quickly recognize the relationships of the food chains and develop the complex relationships of the example food web.

Through discussion and questioning, students' prior knowledge and misconceptions about relationships between life forms can be brought out. Teachers should be aware of students' prior knowledge and any potential misconceptions they may hold about content to be learned. (Watson and Konicek, 1990; Appleton, 1993) The teacher can then address these misconceptions through a new set of questions, direct instruction, or new experiences.

Group Work - Decisions to make

After helping students understand the advantages of food webs over food chains, we distribute the flashcards to student groups of 2 or 3 and give instructions to try to put the organisms on the cards into a food web. Students might make their webs using large whiteboards or butcher paper. Common biomes we have used include open-ocean, coral reef, Arctic Ocean, Antarctic Ocean, and a kelp forest. Additional biomes that could be used in classrooms with a large number of students include deep ocean vent system, coastal water systems, and mangrove forests. These latter food chains are slightly more complicated, and inclusion will likely depend on the age of students and the content goals of the classroom.

One way to conduct this activity is to have all groups work with all the biomes listed above providing each group some experience with each biome. Another method is to select only one or two biomes for all groups to work on. Having all groups work on the same biomes creates opportunities for more focused discussion about the different designs of the food webs. These discussions can challenge students to rationalize and explain how they constructed their food webs and evaluate other students' webs.

A completely different approach is to have each group work on a different biome or set of biomes. During class discussions or presentations, the students are able to bring in their specific knowledge to help their classmates understand the biomes with which they worked. Also, if all student groups work on different biomes, the teacher can encourage students to notice the commonalities between the biome food webs despite the diverse organisms.

Drawing students' attention to these commonalities encourages students to focus on understanding ideas behind food webs and their application rather than simply memorizing which organisms eats which."

When working with beginning level or younger students, we typically have each group work on similar food webs so that we can better discuss the decisions they have made. By having each group work with the same biomes, all students have similar experiences and background knowledge for class discussions. When working with more advanced students, we have the small groups each work with different biomes. By having each group work with different biomes, we are able to encourage the students to see commonalities in the diverse food webs they have created.

Constructing Food Webs

Once the flash cards have been distributed and students are working, teachers must resist the temptation to tell students the correct answers. Have the students try to complete the food webs on their own. Having students discuss and struggle with how to create their food web encourages students to think critically and actively mentally engage with the task. If teachers simply tell students how to construct the webs, higher order thinking and mental engagement cannot as easily be encouraged.

While students are working in groups, we are sure to move around the room to monitor and guide student thinking. Because many students will not be familiar with all the organisms and their position within various food chains and webs, the types of questions used to help guide students are important. Sample questions include:

- "Looking at the organism in front of you, what characteristics of the organism might provide clues to help you fit it within your system?"
- "What would you like to know about this organism to help in your decisions?"
- "Where could you go to learn more about the organism in question?"
- "What are some potential advantages of using the Internet? What are some potential disadvantages of using the Internet?"
- "If we don't have a particular reference resource, where else could you look for help?"

These questions encourage students to think through their logic and help them engage with difficulties rather than giving up. Such questions also encourage students to interact with each other and other resources to achieve a shared goal rather than rely solely on the teacher.

Presentation and Discussion of Webs

After providing students the time to work through building a food web, the next step is to bring the students together as a large group to discuss the food webs they have created. This discussion can be done in the form of group presentation to the class, jig-saw, a whole-class discussion, or challenging students to create their own method of sharing ideas. The form of discussion we chose included having students draw and write about their food webs on white boards followed by a 2-3 minute presentation of their ideas to the class.

We remind students that when they share their observations and the food webs they have created they must express their ideas in a way that both the teacher and their peers can understand. We also remind the students of our expectations for listening to other groups' ideas. We expect the students to be actively listening, taking notes, and asking questions. Two groups may have created entirely different food webs and by listening to one another's ideas, making lists, and forming questions, students are actively engaging in learning.

To help students wrestle with ideas during the discussion or presentations we ask questions such as:

- "How did you determine which organism would be at the top of your food web?"
- "How did you determine which organism would be at the bottom of your food web?"
- "What is another possible way you could construct your food web?"
- "What might happen if a particular organism was taken out of the food web (because the species died out or found a more favorable environment)?"
- "What might happen if a new organism was introduced into the environment? What are some ways that you think it would affect the food web?"
- "How does your food web compare to other groups' food webs?"
- "In what ways does your food web differ from other groups?"

We pose questions such as those above to not only push student thinking, but also to help guide student thinking. We try to pay attention to the amount of support our students need and then scaffold student thinking – providing copious amounts of support when needed, and slowly backing off as students become proficient (Dixon-Krauss, 1996). After asking students to explain their rationale for particular decisions, we then carefully consider student responses to judge how well students understand the concepts. If students are struggling, we'll step in with follow-up questions that draw students' attention to misunderstandings or shortcomings. Examples of questions we have used include,

- "You drew connections from this organism to only one other organism. What might happen to the predator of this relationship if the prey all died?"
- "You have not noted anything that the bacteria feed on. Why might this be problematic?"

During the resulting discussion, an opportunity is created to draw students' attention to the cyclical nature of energy and nutrient flow. Additionally, our conversations will lead to a discussion of the sources from which plant life draws energy. Asking these questions helps students better understand the role of the sun in most all of Earth's ecosystems.

Teacher Behaviors

During any teacher-student interaction, appropriate wait-time before and after student responses is critical to encourage students to work through problems. We use wait-time as an effective tool to give students a chance to think before they respond while placing expectation on students to respond. In addition to wait time, we strive to demonstrate positive nonverbal behaviors including: calming and inquisitive facial expressions and gestures, appropriate voice intonation, walking around the room, listening intently to student responses, and using student ideas to guide decisions (Rowe, 1986; Penick, Crow & Bonnestetter, 1996). Overlooking *any* of these teacher behaviors can quickly diminish the quality of student responses.

Explicit Inclusion of the Nature of Science

The National Science Education Standards state that "all students should develop (a) the abilities necessary to do scientific inquiry, and (b) understandings about scientific inquiry" (NRC, 1996). For this reason we chose to conduct this activity as an inquiry-based experience. Another reason we chose to use an inquiry-based experience is to promote a deep understanding of the nature of science. Through careful questioning, students are guided to see there is no universal "scientific method" and how their observations and prior experiences influence their ideas. Another nature of science idea we raise with students' is how food webs are human constructs designed to impart organization on the natural world. Questions that help students draw attention to these nature of science topics include:

- "In what way did you not follow a step-by-step procedure?"
- "How did your prior thinking/knowledge influence your decisions?"
- "To what extent are these food webs invented?
- "How do the food webs help us organize the natural world?"
- "How might our understanding of these food webs change in the future?"
- "What role did creativity play in this activity?"

Teaching about the nature of science can be difficult, but we always find that the discussions are well worth the effort. We find that writing out several key questions in advance, like those listed above, is essential when preparing for these sorts of discussions.

More than just facts

The manner in which this activity is conducted promotes more than just acquisition of knowledge. Throughout this activity, students are encouraged to use effective social skills when communicating ideas to classmates and the teacher. Students use communication skills while discussing, writing, and recording observations and speculations. Students also demonstrate their use of critical thinking skills when making connections and drawing conclusions from the observations they make and the food webs they create. This activity also promotes student creativity by encouraging students to choose how they will create their food webs. Students make speculations about the connections between different organisms and their roles in the food webs.

Student do not learn in a vacuum. The right conditions must be present, including a welcoming learning environment, cognitively challenging activities, high expectations, and support. The teacher provides these conditions. This article presents an interesting activity with much of what we have learned of how we, as teachers, can foster an environment that promotes learning outcomes that engage all students.

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