TEACHING
FOOD RELATIONSHIPS

SAURAV SHOME

Children are introduced to food relationships at the elementary level through food chains and food webs. Research suggests that both models can leave students with misconceptions. What are some of the most common misconceptions? What are some pedagogical strategies to address them?

Understanding the idea of food relationships in ecosystems involves an introduction to food dependence among different organisms. This includes the role of producers, consumers and decomposers; the process of photosynthetically building complex matter from simpler molecules and decomposing complex matter to simpler matter; the transformation of energy during each process; and the role of humans in these relationships. It is often difficult to highlight all these aspects without oversimplification.

A common pedagogical approach is to begin with a simpler model of food relationships, and build an understanding of more advanced concepts around it. This means that the teaching of food relationships at the elementary level is traditionally limited to introducing food chains or at most food webs. Teachers report that students generally find both these models easy to understand. However, research suggests that both models leave students with many misconceptions about food relationships.

Common student misconceptions

Here are some common student ideas around a simple food chain (see **Fig. 1**) that many elementary-level students are familiar with:

1. A change in the population of a first-order consumer will not affect one or more producer populations. Students may, for example, believe that a change in the grasshopper population will not affect the grass population. The assumption that producers are independent of consumers can extend itself into the narrow view that the resources available to us are infinite or too abundant for us to be concerned about their depletion.

2. A change in one population in this chain will only affect another population if the two are in a predator-prey relationship. Students may assume, for example, that a change in the frog population will affect only the grasshopper and snake populations, but not that of the grass or eagle populations. While this

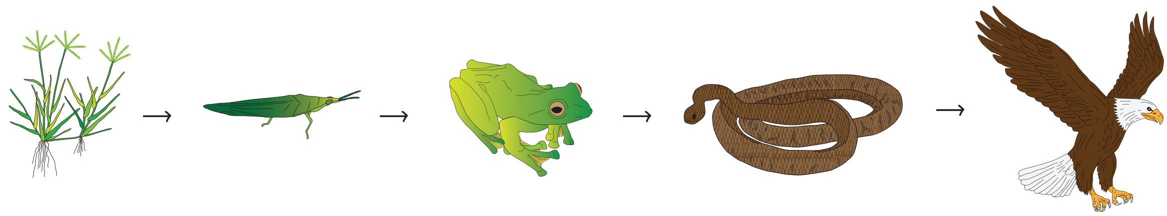

Fig. 1. A simple food chain that is commonly used to introduce food relationships at the elementary-school level.

means that students can identify the effect of a change in both directions, their understanding is limited to the immediate linear connections seen in the chain. They may often assume the existence of some strong self-adjusting mechanism in the ecosystem that compensates for any disturbance beyond these immediate connections.

3. A change in one population will not be passed along several different pathways of a food web. Students may assume, for example, that a change in the grasshopper population will not cause any change in the population of grazing animals or the carnivores preying on them.

4. A change in the size of a prey population has no influence on the population size of its predator. Students may assume, for example, that a change in the size of the frog population will not affect the size of the snake population in the same ecosystem. This misconception may be particularly common if food relationships are seen as isolated events rather than being connected with other biological processes (like reproductive advantage or disadvantage in the context of food availability).

5. A population located higher in a given food chain within a food web preys on all populations located below it in the chain. This can arise due to the simplistic presentation of food chains, the absence of discussion on the many species-specific relationships within a trophic level, and erroneous generalizations based on limited examples (like the fact that tigers eat many herbivores). In some cases, students can misinterpret the diagram of a food pyramid to mean that the species placed at its apex consumes all the species that appear at levels below it.

6. When the size of one population in a food web is altered, all other populations will be altered in the same way. While a student's ability to see interconnections may be heartening for teachers, seeing all the relationships in a web as being linear is a simplistic and incorrect understanding of food relationships.

7. Decomposers are not part of food chains or food webs. Since examples of food chains and food webs used in elementary-school textbooks do not explicitly mention decomposers and other microscopic organisms, many students may assume that these organisms have no role in the food relationships of other organisms.

8. Food chains and food webs involve a flow of matter, not energy. Since food chains and food webs are traditionally presented only in terms of one organism feeding on another, most students do not understand that each such relationship also involves the transfer of energy.

Addressing student misconceptions

How do we introduce food chains and food webs to elementary-level students in ways that address these misconceptions? Here are some strategies:

1. Introduce students to food relationships of specific organisms within a larger, more general category. For example, introduce general food relationships of insects, then highlight differences between the feeding habits of specific categories of insects like butterflies, ants, and cockroaches. Use this to discuss differences between the host plants of two or three different species of butterflies. Apart from offering a less simplistic perspective to food relationships, this exercise can help students expand their species vocabulary, and appreciate the importance of biological diversity in ecosystem health.

2. Widen the scope of food relationships discussed in class. Share examples where a predator or its prey are in other kinds of food relationships, like that of sun bears feeding on fruit and honey. In addition to predator-prey relationships, introduce and explore examples of saprophytes and parasites from the real-world contexts of your students. This could include observations of bracket fungi on decaying logs of wood, or of mosquitoes sucking blood from humans, cattle, and dogs.

3. Reduce emphasis on hierarchy. Traditionally, food relationships are represented as a pyramid with different trophic levels. Such representations suggest a linearity that causes students to mistakenly believe that most organisms fit a single trophic level, or that organisms at a higher trophic level consume organisms at all the lower tropic levels etc. Challenge this by using a networked web structure to discuss trophic levels.

4. Highlight the recycling of matter through food relationships. Describe, for example, how producers make food, decomposers act upon dead organisms breaking them down to simpler compounds, and how the carbon dioxide released through respiration becomes the raw material for photosynthesis.

5. Bring energy into the picture. Discuss the connection of food dependence to the transformation of one form of energy into another. Share, for example, how solar energy is converted to chemical energy in plants during photosynthesis, or how digestion in animals involves the transformation of chemical energy in food to thermal energy (used to regulate our body temperature) and mechanical energy (used in muscle movement).

6. Introduce activities and case studies to illustrate the dynamic and non-linear nature of relationships in food chains and food webs. Encouraging students to observe interactions between even a small number of species over time in local natural or artificial ecosystems can give them a sense of nonlinearity. One approach is to begin with examples of food relationships involving animals (including humans) familiar to students in their own contexts. For example, encourage children to think about what domesticated animals eat; and to watch and record the feeding habits of commonly observed birds, insects, rodents, etc. Use these observations to build class discussion. Another approach is through activities. For example, help students learn to take care of ants, earthworms, and butterflies in a terrarium that they have designed and built themselves. A third approach could be to use computer-based animations. For example, get students to build animations around case studies to show changes in the many food relationships that exist in particular ecosystems.

Parting thoughts

Introducing students to food chains and webs within a wider context of interconnected relationships that are nonlinear, include humans, change over time, involve the cycling of both matter and energy, and are observable in our real world can leave students with fewer misconceptions. While we offer some broad pedagogical strategies towards this goal, these are meant to be suggestive rather than sacrosanct. They are also likely to be most effective if used or adapted in a context-sensitive manner.

Key takeaways

- While many teachers report that elementary-level students find food chains and food webs easy to understand, research shows that both models leave students with many misconceptions about food relationships.
- Most common misconceptions arise from seeing food relationships as distant, linear, isolated events in the cycling of matter, which do not involve humans.
- These misconceptions can be addressed by presenting both models within a wider context of nonlinear interconnected relationships that change over time, involve the cycling of both matter and energy, include humans, and are observable in the real-world.

Notes: Source of the image used in the background of the article title: Some of the food we grow and consume. Credits: Marco Verch Professional Photographer. URL: https://www.flickr.com/photos/30478819@N08/48788305713. License: CC-BY.

References:

1. Barman, C. R., Griffiths, A. K., & Okebukola, P. A. O. (1995). High school students' concepts regarding food chains and food web: A multinational study. International Journal of Science Education, 17 (6), 775–782.
2. Carlsson, B. (2002). Ecological understanding 1: Ways of experiencing photosynthesis. International Journal of Science Education, 24 (7), 681–699.
3. Parab, Y. & Natarajan, C. (1998). Ecological Balances, Activity Based Foundation Course on Science, Technology and Society, (Series editor) Chitra Natarajan. Mumbai: HBCSE.
4. Shome, S. & Natarajan, C. (2009). A short course on Energy & Environment for middle school students and a study of students' ideas on the topic. Technical Report. Mumbai: Homi Bhabha Centre for Science Education.
5. Valenti, J. M. & Tavana, G. (2005). Report: Continuing science education for environmental journalists and science writers in situ with the experts. Science Communication, 27 (2), 300-310.

Saurav Shome is associated with Azim Premji School, Matli, Uttarkashi. He is also a research scholar at Homi Bhabha Centre for Science Education (HBCSE), Bombay. His research interests include teacher professional development and project-based learning. He can be contacted at saurav.shome@azimpremjifoundation.org.